EXPLORING THE IMPACT OF DIGITAL LIMITATIONS ON DIGITAL EFFECTIVENESS FOR STUDENTS IN A VIRTUAL LEARNING ENVIRONMENT

by

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ABSTRACT

Virtual learning has grown to become a needed and viable option for teaching and learning in secondary education settings. Students and teachers can engage and share with each other within a few clicks. As virtual learning grows as a popular option to share learning experiences using computers and the Internet, the problem surrounding inequalities of access still plague our society. Those inequalities are formally known as the digital divide. As Internet access and the use of information technology have increased, the topic of the digital divide has evolved to focus on addressing digital limitations of access, behavior, and cognition and how they affect digital effectiveness.

Using data from participants in the supplemental virtual learning program in Alabama, this study examined how access to Internet and computer technology, behavioral limitations of personal attitudes and motivations, and cognitive limitations of personal experiences and capabilities affect the digital effectiveness of their virtual learning experience. Results showed that there are relationships between certain demographic variables to access limitations, behavioral limitations, and cognitive limitations. Results also showed that there are relationships between digital limitations and how those limitations affect students' perceptions in their virtual learning environment.

DEDICATION

This dissertation is dedicated to Yvonne, Jacki, and Adolphus. I am saddened that you are not here to see me finish this process, but I am forever grateful for the impact you had on my life and the love and support you shared before your transitions. Yvonne, I hope that this research is indeed "saying something."

To my Mother, thank you for teaching me to always do my best, not to give up, and lean not to my own understanding but acknowledge God in all my ways. Thank you for the (tough) love and support and showing me the power of a good education and teaching me to do something to help somebody else.

LIST OF ABBREVIATIONS AND SYMBOLS

a	Cronbach's measure of internal consistency
df	Degrees of freedom: number of values in a statistical calculation that are free to vary
F	F-statistic determines if there is a statistically significant difference between two populations' means
M	Mean: average of all numbers
Mo:	Mode: the number that is repeated most often
SD	Standard Deviation: measures the variation of a set of data
p	Null hypothesis testing used to quantify the statistical significance of results
r	Pearson's r: measures the correlation between two variables
<	Less than
=	Equal to

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CHAPTER I

INTRODUCTION

Howard Rheingold labeled the Internet as the "great equalizer" (1991). The Internet makes it possible for all types of information to be distributed in many ways, whether it is using Google to look up a recipe or watching a YouTube tutorial on how to solve for *x* in an equation. For some, the Internet has replaced the library as the primary tool for conducting research and serves as an efficient way to distribute information. We use the Internet to communicate with others using social media, receive real-time traffic changes and estimated time of arrival through GPS navigation, shop for clothing and groceries, and pay bills with one click through our bank. The Internet of things sends and receives data through everyday devices. It is simple to ask Internet-connected digital assistants Alexa, Google, or Siri any question and receive an instant and correct response. In short, the Internet provides access to almost the totality of human knowledge, which has led to a democratization of knowledge and helped to shrink the world.

According to Ryan and Lewis (2017), in 2000, about half of all households in the United States (51%) had a computer. In 2015, this percentage had grown to 79%. Nevertheless, a third of American adults do not have high-speed Internet at home due to inadequate bandwidth infrastructure, overloaded networks, and/or expensive costs, according to a 2015 Pew Research Center survey (Horrigan & Duggan, 2015). For many of these people, mobile devices serve as their primary means of Internet access (Bogard, 2017). This is problematic, as it is increasingly becoming more necessary for everyone to become computer and Internet literate (Geçer, 2013).

According to the Organization for Economic and Co-operative Development (OECD, 2014), there is an increasing worldwide demand for competent and skilled Information Communication Technology (ICT) practitioners and digitally literate people in society and in the workplace. There is a need for the following digital skills in all areas of employment:

- Technical skills—being comfortable with computers at all levels of usage.
- Information handling—to be able to locate, evaluate, produce, and comprehend information.
- Communication—sharing information via email and texts as well as using social networking platforms to collaborate.
- Work-related skills—technical skills for their industry.
- Personal attributes—cognitive skills to be able to keep up with fast-paced technical changes.
- Personal attitudes—attitudes will affect if and how a person uses and accepts technology. (Leahy & Wilson, 2014)

Digital skills enable a person to succeed in finding, evaluating, and creating information for higher education, training, and employment (Leahy & Wilson, 2014). America's secondary sector has placed a major emphasis on ensuring students graduate college and career ready as there is a strong correlation between educational outcomes and economic development (SREB, 2018). One of the biggest challenges the United States faces is to meet its workforce and educational needs by closing the readiness gap. Most students graduating from high school are not prepared for postsecondary studies or the workforce (SREB, 2018). There is a disconnection in the conversation between college- and career-ready skills and the important role technology skills and digital tools play in schools. Fifty-six percent of educational stakeholders (high school level administrators, parents, and students) ranked technology use as extremely important (Project Tomorrow, 2013). Even though technological advances have led to a rise in access to the Internet and the devices to connect to it, inequalities and gaps are still plaguing the 21st-century educational system (Moore & Lewis, 2014). This widening of educational inequities based on access to the Internet is commonly referred to as the digital divide.

Research into the digital divide continues to provide useful insights into its significance and meaning (Barclay & Duggan, 2008). Early research on the digital divide focused on physical access and the dissemination of ICT as a measurement of digital readiness and benefits from ICT. Now attention is shifting toward the effectiveness of available ICT and use (Barclay & Duggan, 2008). The focal point of digital effectiveness is the individual ICT user and the levels of purposeful ICT use he or she achieves.

As virtual learning grows to become a popular option for sharing learning experiences to diverse populations using Internet and technology, the problem surrounding access and ICT use involves discussing digital limitations (not the complete existence or nonexistence) of access levels and use of ICTs (Bellini et al, 2012). It is important for people to have access to ICT and know how to use them effectively as "without Internet access and without necessary skills that accompany the attitude of using new information and communication technologies, individuals cannot get information electronically and cannot be informed by organizations and institutions through information technology" (Donat et al., 2009, p. 38). Therefore, it is important to better understand users' digital limitations by examining how physical access limitations, digital behaviors and attitudes, and cognitive limitations affect the users' overall effectiveness of virtual learning programs.

Statement of the Problem

The traditional face-to-face classroom can be seen as somewhat isolated with collaboration limited to students within the same building or classroom. With the integration of technology and the Internet, students can communicate with each other across their state or around the world virtually using technology-based tools. The walls of the classrooms are no longer seen as a barrier because technology enables new ways of learning, communicating, and

working collaboratively. As the face of teaching and learning evolves, we now see the growth of K-12 virtual education, schools, and course options as learning opportunities to traditional face-to-face settings (Digital Learning Collaborative, 2019).

The K-12 virtual education option has many benefits. These options range from full-time virtual schools, where students can receive all credits necessary for completion and graduation, to blended programs that use digital content that mainstream teachers are using to reinforce instruction in their physical classrooms (Digital Learning Collaborative, 2019). These programs reach underserved regions, expand educational opportunities for students who are unable to attend traditional schools, provide access to resources and instructors not locally available, and increase student-teacher communication (Cavanaugh et al., 2004). Virtual schools that serve students across entire states such as Connections Academy have an estimated enrollment of 310,000 students nationwide (Digital Learning Collaborative, 2019). State-supported virtual schools/programs serve about 420,000 students with almost 1 million online course enrollments (Digital Learning Collaborative, 2019).

As Internet access and the use of information technology have increased, the topic of the digital divide has evolved to focus on addressing digital limitations of access, behavior, and cognition and how they affect digital effectiveness (Bellini et al., 2016; Eastin & LaRose, 2000). The assumption is that all students have grown up with and have been interacting with digital technology and are willing to embrace it as a learning tool (Klein, 2016). According to Geçer (2013),

> the combination of computer technologies in educational environments and the delivery of the educational content with traditional education in an electronic environment can increase the number of applications that activate the students, thereby facilitating the achievement of information and promoting efficiency and productivity in education. (p. 51)

Many the discussions involving the digital divide are applied to the physical access of personal computers and the Internet among demographic categories including income, education, age, sex, and ethnicity (Van Dijk, 2012). Although we see schools integrating technology at a rapid pace, students who are enrolled in lower funded school districts, tend to have insufficient access to technology which can obstruct them from learning the ICT skills that are especially important to success today (Soltan, 2019), There are still instances where K-12 schools are unable to fully adopt and use classroom technology because of poor Internet connectivity (Cortez, 2017). Fifty-four percent of all teachers said their students had acceptable Internet access at school, but only 18% said their students had adequate access at home. Urban and rural teachers are likely to say their students have poor to no Internet access at home (Soltan, 2019).

Cognitive limitations are strongly linked to the digital divide. These limitations refer to the ways people learn, produce, understand, share, learn, collaborate, and create using technology (Fonseca, 2010). Usage is largely linked to demographic characteristics of users and technical connections (e.g., social class, education, age, gender and ethnicity, the effectiveness of the connection). "Usage access" is also succeeded by the motivation to use ICT, material access, and having appropriate skills (Ghobadi & Ghobadi, 2015). For students to feel comfortable with their skills and have positive attitudes regarding computer technologies, they must be able to successfully achieve within these environments as well as believe in their capabilities. Belief and trust in one's capacity to do something is termed self-efficacy (Geçer, 2013). Computer self-efficacy is the belief in the capability of doing a task using the computer.

Therefore, it is important to study how digital limitations impact self-efficacy and behaviors on the effective use of technology, especially for those that must use it to complete computer-based tasks. Behavioral limitations are those that hinder one from being able to fully

use and master ICT. Cognitive limitations can manifest themselves into inappropriate behavior including technophobia or technoaddiction (Bellini et al., 2016). It is important to study digital effectiveness in students who are taking classes in a virtual environment. As K-12 virtual learners come from various economic backgrounds, school locations, and take courses in various places and environments at different times (some with lots of hands-on assistance, some not so much), these digital limitations vary and can affect the ability of the students successfully passing a course. This study examined the digital limitations of students who are taking courses in a virtual environment and how it affects overall digital effectiveness and success.

Theoretical/Conceptual Frameworks

Digital Limitations Model

Bellini et al. (2010) proposed the term "digital limitations" to highlight the individual and their levels of access and use of ICTs, as these individuals present three forms of limitations on the level of access, cognition, and behavior.

- Access limitations refer to complications related to social and material resources and access to ICT. Lack of access includes slow to no bandwidth, outdated hardware and/or software, unhealthy environments such as poorly ventilated computer labs, insufficient time to perform tasks, and other factors (Bellini, 2018; Bellini et al., 2012).
- Behavioral limitations are the difficulties a user can experience when applying his or her digital abilities. A user can experience technophobia or technoaddition or giving less attention to the assigned tasks (Bellini, 2018; Bellini et al., 2012).
- Cognitive-information limitations are difficulties with an individual's abilities to use ICT effectively. Effective use can be demonstrated as the ability to seek, select, process, and

apply information in digital media. Lack of interest and low computer self-efficacy can affect abilities (Bellini, 2018; Bellini et al., 2012).

Computer Self-Efficacy

Self-efficacy refers to an "individual's belief (confidence) about his or her abilities to perform a specific task within a given context" (Stajkovic & Luthans, 1979, p. 130). Strong self-efficacy enables human accomplishments, which is one of the key elements of the Social Cognitive Theory (Bandura, 1997).

Compeau and Higgins (1995) defined computer self-efficacy (CSE) as "an individual's perceptions of his or her ability to use computers in the accomplishment of a task" (p. 191). The psychological barrier caused by unequal access to and availability of ICT can increase the probability of giving those underserved students the chance to develop CSE, which could then translate into lower learner achievement and outcomes (Attewell & Battle, 1999).

Digital Effectiveness

The digital divide has frequently been defined as the inconsistencies in the accessibility of and access to digital technology across various individuals (Barclay & Duggan, 2008). Research on the digital divide phenomenon has evolved and slowly decreased since its inception in the 1990s as the division between the haves and the have-nots. As digital divide research continues to be conceptualized and reshaped, Barclay and Duggan (2008) suggested digital effectiveness is "establishing the ability to maximize the capabilities of available technologies within the particular environmental context to obtain positive economic returns on the adoption and use of the ICT." (p. 2)

Bellini (2018) defined digital effectiveness as the desirable state of positive results to be recognized in the interaction of humans, information, and technology. Digital effectiveness is the

expectation that the use of technology builds on the development of the interactions among Internet and material access, use and skills, and cognition and intention toward the Internet and computers (Bellini, 2018).

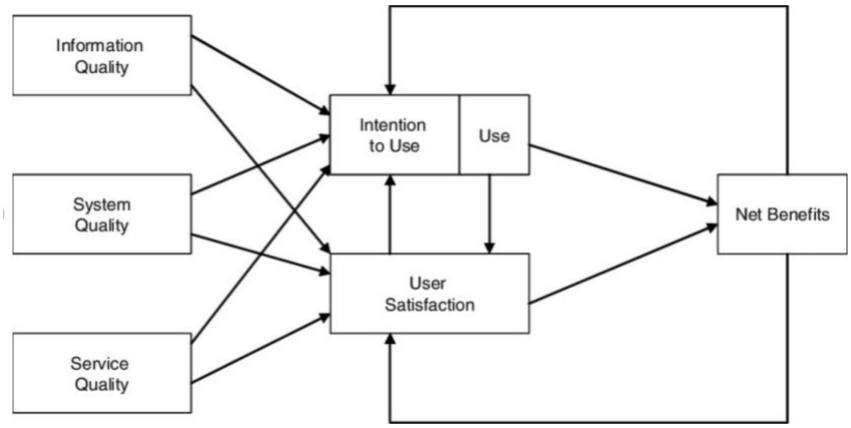
Information System Success Model

DeLone and McLean's Information System (IS) Success Model was used as the framework to measure digital effectiveness of the virtual learning environment. The original model, based on Mason's Modification of Shannon and Weaver's Model of Communication, included three levels of information: the technical level, the semantic level, and the effectiveness level (Shannon & Weaver, 1949). Mason adapted the original model and extended the effectiveness level to include receipt of information, influence on the receipt, and influence on the system (Mason, 1978). DeLone and McLean identified categories for system success by mapping an aspect of IS success to each of Mason's effectiveness levels generating six variables: System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organizational Impact (Petter & McLean, 2009).

Ten years later, DeLone and McLean modified their model to address limitations to the original model. Service Quality was added to measure the service quality of the information system's success. Another modification was the deletion of Individual Impact and Organizational Impact as separate entities. Last, the Use variable was improved by including the Intention of Use as a measurement that would affect Use and User Satisfaction (DeLone & McLean, 2003, Petter & McLean, 2009).

Figure 1

DeLone and McLean Updated IS Success Model



Statement of Purpose

The purpose of this study was to examine how digital limitations (access, behavioral, and cognitive) impact the digital effectiveness of secondary level students enrolled in a virtual learning environment. This study examined how access to Internet and computer technology, behavioral limitations of personal attitudes and motivations, and cognitive limitations of personal experiences and capabilities affect the digital effectiveness of the students' virtual learning experience. Digital effectiveness was measured by using the Information System (IS) Success Model (DeLone &McLean, 1992).

Significance of the Study

Online, blended, and digital learning in K-12 continue to grow and include an array of school programs, resources, and tools. According to Horn and Staker (2011), virtual learning serves students to ensure quality and equitable learning experiences. Small, rural, and urban schools can offer a broad selection of core subject courses and electives with highly qualified teachers, or remedial courses for students who need to recover credits to graduate, or service home-schooled or homebound students.

> Online learning started by serving students for whom there was no alternative for learning—in the advanced courses that many schools struggled to offer in-house; in small, rural, and urban schools that were unable to offer a broad set of courses with highly qualified teachers; in remedial courses for students who needed to recover credits to graduate; and with home-schooled and homebound students. (Horn & Staker, 2011, p. 1)

The Digital Learning Collaborative (2019) report stated 31 states allow statewide online schools (schools that serve students across the state) with an estimated 310,000 students enrolled. There are 23 states that offer state virtual schools (supplemental online course programs that are state supported). These programs serve about 420,000 students with almost 1 million course enrollments.

Several states are utilizing virtual and blended learning environments, with policy actions to support virtual learning including supporting competency education, removing seat time-based restrictions, and providing greater regulatory flexibility to schools (Patrick et al., 2016). In 2015, 98 bills were considered in 28 states; 36 were enacted (Molnar et al., 2017). States are creating policy and legislation to ensure the balance of power and funding between for-profit programs and state run programs, to ensure a balance of open access and quality experiences (Ash, 2019; Molnar et al., 2017). For example, in 2015, the Alabama legislature passed a measure requiring every state school system to adopt a plan to provide an online option for students. Likewise, the Florida K-20 Education Code gives parents the right to choose educational options such as Florida Virtual School for their children. Finally, Article 5F-4: Accessibility and Equity in Public Education Enhancement Act of the West Virginia Code, a county board or a multicounty consortium may create a virtual instruction program for one or more schools serving any composition of grades kindergarten through 12 by adopting a policy creating the program and after adopting the policy may contract with virtual school providers.

The Digital Literacy and Computer Science (DLCS) standards blend the ability to use information and communication technologies with the study of computers to create an integrated approach to instruction that can enhance any existing educational subject. Alabama is an early adopter in these practices; being one of only 15 states in the nation to adopt them (Alabama Today, 2018). Although the laws have made the option of virtual learning more accessible, the infrastructure needed to support this initiative is still an issue as over 31% of rural Americans do not have broadband at home (Alabama Today, 2018; Valentine, 2018). Some states have seen a significant increase in the number of people of color who live in rural areas, with 27% of people of color who live in rural America not having access to Internet at home (Valentin, 2018). The state of Alabama proposed the Alabama Ahead Act, a $50 million funding plan (Crain, 2015). The priority of the Alabama Ahead Act is to "establishment of a high-quality, standards-based wireless local area network (WLAN) infrastructure capable of providing all teachers and students with sufficient Wi-Fi broadband access in all classrooms and common areas of schools, where feasible." However, there is no discussion of purchasing adequate physical devices that can support the updated network infrastructure. Because of this significant shift in Alabama's educational policy, it is important for policymakers, educational leaders, and teachers to understand that although students may have some contact with computer technology, digital limitations may have a negative impact on their effectiveness and success in a virtual learning environment.

Limitations of the Study

The following limitations applied to this study. Potential participants were required to be enrolled in the virtual learning program. The goal of the study was to have a diverse sample profile. However, there was uneven disbursement of data due to the schools that participated in

the program during the data collection period. Participants had a specific block of time that was allotted for survey completion and data collection. The period allotted for data collection could affect the sample size. Participants were asked several questions about their experiences with and beliefs about their virtual learning courses; self-reporting this information was a limitation. Their responses could have been biased according to the answers they thought were expected or ideal.

Research Questions

The following question guided this research study:

1. Is there a relationship among demographic factors, digital limitations, and digital effectiveness in a virtual learning environment?

Definitions of Key Terms

Information Communication Technology—the technologies that provide access to information through communications (Khan et al., 2015), including any communication devices, encompassing radio, television, cell phones, computer and network hardware, satellite systems, and so on, as well as the various services and appliances with them such as video conferencing and distance learning (Akarowhe, 2017).

Digital Limitations—addresses a user's barriers to appropriately access the information and communication technologies (ICTs), as well as his/her cognitive abilities and behaviors towards effective ICT use (Bellini et al., 2016).

Digital Effectiveness—describes the user's purposeful use of ICTs in desirable ways (Bellini, 2018).

Virtual Learning—Educational setting where time, location, or both separate the instructor and student. Learning delivered through an online format (Robinson, 2007).

Computer Self-Efficacy—an individual's perceptions of his or her ability to use computers in the accomplishment of a task (Compeau & Higgins, 1995).

Summary

The Internet has granted access to large quantities of information to billions of people around the world and is seen as the "great equalizer." Unfortunately, technology access is not a right, so there are millions of people living in the United States with limited or nonexistent access to various forms of Information and Communication Technology.

Education is quickly moving in the direction where students can learn without being in a typical brick and mortar classroom. While those born in the past 20 to 30 years are assumed to have strong digital capabilities due to their proximity to the rise of the Internet age, there are still digital limitations that affect the effective use of ICT. Virtual learning has granted the opportunity for students to receive instruction on a wide variety of subjects and topics, regardless of their physical location. The question must be asked, how do digital limitations affect the group of students that live in rural or lower-income areas who use virtual learning as a viable option to traditional face-to-face learning? This study examined how digital limitations affect the digital effectiveness and success of students enrolled in a virtual learning environment.

CHAPTER II

REVIEW OF THE LITERATURE

Over the past 100 years, education has seen significant innovations and modernizations that have changed the way we teach and share information with students through open and flexible resources (del Campo et al., 2012; Simpson & Anderson, 2012). Early innovations such as the printing press and later the postal service created an opportunity for a more systematic approach to share information over various distances (del Campo et al., 2012). The invention of broadcast technologies (radio and television) made it possible for information to be delivered via sound and video in real-time (Simpson & Anderson, 2012). Computer-mediated education gave students the tools to engage by sending an electronic email and communicating through audio and video conferences (Simpson & Anderson, 2012). Technology allowed flexibility and interaction in course delivery (Simpson & Anderson, 2012). Currently, computers and the Internet provide opportunities for students and teachers to have greater communication, participation, and collaboration using up-to-date resources (Molnar, 1997).

The main characteristic that separates learning in a virtual environment from a traditional environment is the ability to use computers and the Internet to provide instruction to anyone, at any time. Virtual learning also differs from traditional classroom instruction as it shifts control and responsibility from the teacher to learners (Chou & Liu, 2005). Virtual learning presents programs and institutions with possibilities for engaging students and offers greater flexibility in course delivery (Simpson & Anderson, 2012).

While learning in a virtual environment creates promising avenues for equitable learning opportunities, there are still limitations for many students who do not have access to the Internet and/or computers. Gaps in technology access and the ability to proficiently use technology are important considerations if students are to be prepared for various technological tasks (Mosseberger et al., 2003). The limitations in motivations, behaviors, and attitudes could also impact effective digital use. The limitations manifest themselves in digital effectiveness. Digital limitations may hinder individual students who may not have access to Information Communication Technology and in turn, are hindered and disadvantaged by not being fully capable of using computers and the Internet once they have access to it. These disparities can have a long-term effect on student behaviors and performance. This section will give an overview of the literature on technology and Internet use in education and virtual learning in K-12 settings. This section will also define, examine, and discuss the digital divide, digital limitations, the IS Success Model, and digital effectiveness.

Internet and Information Communication Technology Use in K-12 Learning

Computers and technology play a significant role in helping students learn at a faster pace, while also supporting creativity, communication, and self-directed learning (Ramey, 2013). The genesis of computers in education can be traced to the 1960s when the National Science Foundation supported the development of 30 regional computing networks that included 300 postsecondary and secondary schools (Molnar, 1997). By 1974, over 2 million students had access to computers in their schools. By 1975, 55% of the schools had access to computers and 23% were using them primarily for instruction (Molnar, 1975).

Today's learners represent the first generation that has always been exposed to modern digital technology including cell phones, video games, tablets, and other gadgets (Project

Tomorrow, 2013). Because of this, the way students learn has become technology-driven (Project Tomorrow, 2013). Students' ability to access class information such as assignments, grades, and teachers' notes using virtual portals is becoming more of a regular occurrence with 74% of high school students and 61% of middle school students labeling this a regular school activity (Project Tomorrow, 2013). Additional learning activities which involve the use of technology within schools include 47% of high school students creating multimedia presentations, 41% taking virtual tests, 37% accessing a virtual database, 35% using a virtual textbook, 17% watching a video created by the classroom teacher, and 14% conducting virtual experiments or simulations (Project Tomorrow, 2013).

Although there has been a progressive increase in access to high-speed Internet, access to broadband connectivity continues to vary by student demographics. For this reason, President Obama announced the ConnectED initiative in 2013, which committed to increasing high-speed wireless and next-generation broadband to 99% of American schools and libraries by 2018. As a result, between 2013 and 2016, school districts were able to see a 58% increase in high-speed broadband (Education Superhighway, 2017).

Even though there have been various technological advancements in education, there are still obstacles that can interfere with the ability of students in a virtual environment to be effective and successful. For example, students in high-minority schools were half as likely to have high-speed Internet as students in low-minority schools, and students in low-income schools or remote rural areas were twice as likely as students in affluent schools or their urban and suburban peers to have slow Internet access at their schools (Horrigan, 2014).

Virtual Learning in K-12

Virtual learning is when instruction and content are delivered primarily over the Internet (Watson et al., 2005). Because of the flexibility of using the Internet, students and instructors are not required to be available at the same time and place (Siemens et al., 2015). Virtual learning changes education from instructor-centered (traditional classroom) to student-centered, where students have more responsibility for their learning (Koch, 2014; Peterson, 2008). With the increase of virtual learning, K-12 virtual learning programs are constantly and quickly being developed around the world (Setzer & Lewis, 2005). The growth of K-12 virtual learning offerings is a direct result of the perceived benefits they can provide for the school and the student. Some of the perceived benefits of virtual learning for elementary and secondary schools include meeting the needs of diverse learning styles, student and teacher flexibility, and high levels of motivation (Kellogg & Politoski, 2002). K-12 virtual learning can serve the entire student population and provide the flexibility that is not typically found in traditional classroom settings (Kellogg & Politoski, 2002). Students who are homebound, ill/hospitalized, athletes, or those in need of credit recovery or advancement placement can move at their own pace and choose a learning experience that fits their learning needs (Rice, 2006).

Another benefit of virtual education is its ability to expand educational opportunities. Many school districts identified the ability to offer courses that would not normally be offered at their school, as well as meeting the needs of certain groups of students and the ability to offer Advanced Placement (AP) and other college-level courses as the main advantages of virtual learning (Zucker, 2005). By allowing rural and small schools to offer courses that would otherwise not be offered was the major benefit of distance education for K-12 schools (Cavanaugh, 2001). Virtual education also created an opportunity for improving student

outcomes and skills (Berge & Clark, 2005). Because of the increasing number of students enrolled in courses that were not offered in their schools, minority students could take Advanced Placement (AP) courses and AP exams, which resulted in these groups helping their schools make Adequate Yearly Progress (AYP) as measured in *No Child Left Behind* (Berge & Clark, 2005). The updated version of this law the *Every Student Succeeds Act* (ESSA) continues to uphold high academic standards that will prepare them for college and careers.

Several studies examined student performance in K-12 virtual courses to determine the benefits of virtual learning. Cavanaugh et al. (2004) published a meta-analysis of virtual learning outcomes focused entirely on K-12 education. Fourteen studies were included, representing a sample of 7,561 students, in which results in virtual distance education programs were compared to control groups who did not participate in distance education. The meta-analysis results showed that student achievement in virtual courses was as equal to, or better than, traditional face-to-face instruction (Cavanaugh et al., 2004).

McLeod et al. (2005) examined Algebra students' achievement and perceptions of their classroom environments in both virtual and face-to-face learning. The data concluded virtual students consistently outperformed traditional students. The study revealed virtual students can access quality mathematics content and skilled teaching while also achieving high scores (McLeod et al., 2005). Florida Virtual School (FLVS) students outperformed their face-to-face counterparts on a nonmandatory assessment tool. It was believed that the virtual school students who took the assessment were more motivated and naturally higher achieving students (Cavanaugh et al., 2005).

Although these studies presented positive outcomes in comparing virtual students and their classroom counterparts, there was also the issue of student completion and failure to

attempt assessments in virtual courses (Cavanaugh et al., 2005). A 2014 study examined the achievement gaps of at-risk students in an online environment compared to their peers in a traditional face-to-face classroom. Results showed a significant difference in the achievement of at-risk students in a virtual learning environment measured by course completion. For this study, at-risk was defined as students eligible for free or reduced lunch based on household income. At-risk students who took virtual courses without the direct support of a teacher had an average course completion rate of 34% compared to 94% completion for traditional courses. Data also showed that overall, there was no significant difference in course completion rates for both at-risk and non-at-risk students. Based on findings, it could be concluded that the at-risk qualifications in this study did not influence the ability to complete courses. However, course design, interaction, and the individual students and their environments could lead to low completion rates (Hendricsent, 2014).

Technological advancements have changed the mode of teaching and learning and have incorporated a viable alternative option in virtual education. Research has shown various pros and cons, all of which should be considered when making the choice for younger students to enroll. The literature shows that most students can benefit from virtual learning. However, there are various gaps that can influence success.

Description of Virtual Learning Environments

To better understand how K-12 virtual learning is implemented, Rice (2006) summarized Watson et al.'s (2005) classification of the five types of K-12 virtual schools (Table 1). The classifications were divided into two categories: (a) programs that operate within the state's educational hierarchy, such as statewide, multidistrict, or single district and (b) programs that operate as a cyberschool (granting credits and diplomas) or provide supplemental virtual courses

to students who are enrolled in another school. Traditional public schools represent the largest segment of K-12 education, and as such, they are the largest users of virtual learning with approximately 50.1 million students in 98,817 schools (Gemin et al., 2015). Nearly all school districts are using virtual learning at some level. Most schools use virtual courses as supplemental courses, with smaller numbers of students in hybrid and fully virtual schools (Gemin et al., 2015).

Table 1

Watson, Winograd, and Kalmon's Five Categories of Virtual Schools

Type	Description
Statewide supplemental programs	Students take individual courses but are enrolled in a physical school or cyber school within the state. These programs are authorized by the state and overseen by state education governing agency.
District-level supplemental programs	Are typically operated by autonomous districts and are typically not tracked by state agencies.
Single-district cyber schools	Provide an alternative to the traditional face-to-face school environment and are offered by individual districts for students within that district.
Multi-district cyber schools	Are operated within individual school districts but enroll students from other school districts within the state. This represents the largest growth sector in K–12 virtual learning.
Cyber charters	Are chartered within a single district but can draw students from across the state. In many cases they are connected in some way to commercial curriculum providers.

Some virtual school courses operate much like traditional face-to-face courses with student engagement being limited to readings and written responses. In other virtual school courses, the teacher-to-student and student-to-student interaction include communication through

e-mail, discussion forums, chat rooms, instant messaging, real-time audio conversations, and video conferencing. Students can work at their own pace when it is convenient for them.

Although virtual students have various options for interaction and engagement, there are four dominant methods of delivery that have emerged for virtual schooling: independent, asynchronous, synchronous, or a combination of asynchronous and synchronous (Barbour & Reeves, 2009). In synchronous learning environments, students work with virtual content on their own time, under the guidance of a teacher (Friend & Johnston, 2005; Zucker & Kozma, 2003). In asynchronous learning, instruction is delivered by the instructor, who prepares the lessons but does not interact or deliver the content through live communication. The key criticism of asynchronous learning is the lack of participation and interaction with the teacher (Matsuura et al., 2004). In contrast, within a synchronous learning environment students and instructors are connected in real time by videoconferencing, audio conferencing, or both, which is "more like classroom instruction" (Bernard et al., 2004, p. 409). All interactions with content, lectures, discussions, and lesson presentations occur at a specific time with the expectation that all students will be available to participate (Higley, 2014). The disadvantages of synchronous learning are logistics and the limitation of time. All parties must be online at the same time, regardless of location, which may be troublesome to those in different time zones (Fonsway Group, 2019).

Demographics of Virtual Students

There are several variables related to student success in K-12 virtual learning. Mills (2003) examined the frequency counts of 2,600 virtual student enrollments and found that the typical virtual student was just as likely to be male as female and was an A or B student who was either a junior or senior. Roblyer and Marshall (2003) cited that of the students who were

sampled in their study of the Concord Consortium's Virtual High School Project (N = 135), about half were female, most were 16-17 years old, and 70% identified themselves as White. When polled, students who have enrolled in virtual learning courses did so for a variety of reasons that ranged from preference to learning in a self-paced environment, geographical isolation, convenience, flexibility, credit recovery, credit advancement opportunities, conflict avoidance, and the ability to take courses not offered at a local school (Guri-Rosenbilt, 1999; Mills, 2003; Tunison & Noonan, 2001).

In comparison to adult learners, younger students tend to have difficulties in distance learning courses (Colorado & Eberle, 2012). Combinations of these reasons contribute to the motivation and personal success of a virtual student. Research shows that influences such as student attributes and choice of delivery method may also impact motivation (Roblyer, 1999; Tunison & Noonan, 2001). Roblyer and Marshall (2003) postulated that there is a connection between student attributes, motivation, and success. Using an educational success instrument to predict student success in virtual courses (n = 94), success was defined as passing the course with a grade of A, B, or C (n = 73). Students who withdrew or received a D or F in the course were not included in the passing group (n = 21). Seventy items within four major factors may be related to successful behavior in virtual environments that were constructed and presented as a survey to students enrolled in virtual high school courses. Factors included in the prediction instrument were achievement and self-esteems beliefs, responsibility and risk-taking, technology skills and access, and organization and self-regulation (Rice, 2006).

Student readiness is also a concern for K-12 virtual schools. Students in K-12 virtual courses should be able to prioritize work, balance the demands of virtual coursework with other activities, can work independently, approach virtual courses with same commitment and

motivation as conventional classes, be able to dedicate 8 to 10 hours per week for each virtual course, and reserve a class period a day for virtual coursework (Collins, 2002). Students who do well in traditional face-to-face classes may not do well in a virtual environment (Collins, 2002). This could be credited to student motivation, self-discipline, or student readiness (Colorado & Eberle, 2010). Knowing how to utilize the technological ecosystem in virtual learning is also an important contributor to academic success. However, due to the digital divide, students may bring with them wildly varying levels of technology access, availability, and knowledge, which have a direct impact on student success outcomes within virtual learning environments (Goode, 2010).

Evolution of the Digital Divide

The digital divide is defined as the difference in the availability of, and access to, digital technology across various social groups (Barclay & Duggan, 2008). Early research focused on the digital divide and telecommunications point to a multitude of socioeconomic factors as the underlying contributors to the furtherance of the digital divide (West, 2011). Continued research in this area has expanded to include causal levels of the digital divide to include access (first level), capabilities (second level), and outcomes (third level).

First Level—Access

Dewan and Riggins (2005) argued most research on the digital divide focuses on first-level effects of access to technology. The first level of the digital divide is mainly devoted to the observation of the physical divides (access to personal computers and Internet) among demographic categories including income, education, age, sex, and ethnicity. The divide suggests an unfavorable depiction of specific underserved diverse groups (Barber, 2014). For example, in the United States, African Americans were regularly depicted as being on the susceptible side of

the divide (Warschauer, 2002). However, Internet access among African Americans and other multicultural groups fluctuates by income while divisions between Blacks and Whites fade as income increases (Katz & Rice, 2002).

Internet use remains strongly correlated with age, education, and household income, which are the strongest positive indicators of Internet use among any of the demographic groups (Zickuhr & Smith, 2012). The gap that is the closest to disappearing is between Whites and minorities regarding Internet usage, which is at 92% among Whites, 85% among Blacks, and 86% among Hispanics (Anderson, 2019). Although the first level has shifted based on widespread technological advancements and the expansion of high-speed Internet, disparities are still most impactful to those who reside in rural and lower income areas of the United States.

Second Level—Capabilities

In the past 10 years, the digital divide research shifted toward a focus on digital use or digital literacy (Van Dijk, 2012). Research showed the number of people lacking physical access to the Internet has decreased, but there is an important difference that remains in terms of differential skills and the nature of Internet use (Van Deursen & Van Dijk, 2014). "[Digital] literacy encompasses the skills and abilities necessary for access once the technology is available, including understanding the language and component hardware and software required to successfully navigate the technology" (Real et al., 2014, p. 8). Some users with access to computers and the Internet and have shown progress with technology; however, those who are novice and gaining access tend to display a reluctance to use the technology simply because they do not know how (Cohron, 2015).

An alternate view of the first-level digital divide suggests that, in addition to physical access, other essentials such as content, language, literacy, education, and institutional structures

must also be considered when measuring the level of ICT use (Warschauer, 2002). As the number of people having access to Internet increases, it is important to begin to look at the gaps in user abilities. Hargittai (2002) explained the significance of understanding digital skillsets by acknowledging the variations of Internet for information retrieval to identify the second-level digital divide as the Internet spreads to most of the population. There is a combination of factors including physical, human, and social factors (other than age) that influence the second level of the digital divide, including the technical environment (home access, years of Internet use, and access points), an individual's scope and intensity of goals for using technology, and social capital (Jung, 2008). Research has also shown that students who owned computers and had access to the Internet at home had higher grade point averages and scored higher on standardized reading tests (Jackson et al., 2006). These authors showed a significant difference in sociodemographic characteristics stating, "Race differences in-home Internet use may serve to exacerbate existing race differences in academic performance" (Jackson et al., 2006, p. 434).

Third Level—Outcomes

As a result of the digital divide shift from the first level of access to the second level of digital use and skills, research on digital skills is now examining what skills are needed to bridge the digital divide. Van Deursen and Helsper (2015) identified the third-level digital divide as the inequality in the outcomes from Internet use within populations of users who exhibit similar usage profiles and enjoy relatively autonomous access to [computer technology] and the Internet infrastructure.

Internet outcomes are studied much less frequently than Internet skills and uses (Scheerder et al., 2017). Studies that focus on Internet outcomes include demographic determinants, along with social, personal, or economic determinants. Social determinants of

Internet outcomes were primarily linked to network-building and strengthening, both formal and informal (Scheerder et al., 2017).

Talley (2012) tested the digital divide outcomes in the aspect of student achievement in Maryland. Differences in access and use were examined to determine their impact on reading and mathematics achievement levels. In this study, there were 229 public middle schools representing 178,143 students and 12,617 teachers. School data from a self-reported source examined technology access, students' instructional uses of technology, and teacher technology proficiency from the 2007 Maryland Technology Inventory. The study concluded that digital divides exist in the student-to-computer ratio and the number of teachers with classroom computers, and digital access was positively associated with eighth-grade mathematics and reading proficiency scores (Talley, 2012). The study also found divides in students' use of technology for publishing text, organizing information, and communicating information, with access to technology for these tasks/skills positively associated with mathematics and reading scores.

In 2006, Huang and Russell conducted a study focusing on public schools in Oklahoma. The purpose of the study was to explore the relationship between technology accessibility and student academic achievement outcomes. Questioners were distributed to gather data on students' access to computers and the Internet at school and at home, along with identifying ways in which information and communication technologies are incorporated into teaching and other educational purposes. Participants in the survey were elementary principals, fifth-grade teachers, and parents. The study found that technology accessibility and academic achievement (measured by math, science, and reading scores) are directly correlated with the level of technology accessibility at these schools. The schools used several technology resources in

reading and math which would validate this pattern in the data. The findings were not as clear-cut in the subjects of science and writing. The setting of the schools was diverse. Therefore, it was drastically clear that socioeconomic differences, including race and student free lunch eligibility, were also a factor in the study's findings. The literature shows student achievement is dependent upon student's access and use of the technology that is available to them. There were various factors including socioeconomic variables that also played a part in the digital access and digital use, which ultimately influenced the students' digital outcomes.

The digital divide framework describes the digital divide in the learning process. Findings from the literature showed that equal material access to ICT at home and school have a substantial effect on appropriate digital capabilities. A digital capabilities divide is influenced by digital literacy and performing digital tasks. A digital outcome divide is a result of various factors of the first two levels and has impact on skills and knowledge.

Digital Limitations Model

The concept of digital limitations is a new approach to the traditional concept of the digital divide. The term digital limitation focuses on the user's relationship with multidimensional technologies attributes instead of comparing groups of individuals (Bellini et al., 2012). Bellini et al. (2010) proposed a three-dimensional model with three basic forms of digital limitations presented by individuals who interact with each other through various causes and times. The model is supported by Ajzen's theory of planned behavior, which describes the conditional factors of behaviors (Ajzen, 1991).

The three digital limitations include

1. Access limitations: refers to complications related to social and material resources and access to ICT. Lack of access includes slow to no bandwidth, outdated hardware and/or software,

unhealthy environments such as poorly ventilated computer labs, and insufficient time to perform tasks, and other factors (Bellini et.al, 2012 & Bellini, 2018)

2. Behavioral limitations: the difficulties a user can experience to apply his or her digital abilities. A user can experience technophobia or technoaddiction or giving less attention to the assigned tasks (Bellini et.al, 2012 & Bellini, 2018).

3. Cognitive-information limitations: the difficulties with an individual's abilities to use ICT effectively. Effective use can be demonstrated as the ability to seek, select, process, and apply information in digital media. Lack of interest and low computer self-efficacy can affect abilities (Bellini et.al, 2012 & Bellini, 2018).

Access Limitations

Access limitations include the social and physical material difficulties individuals have accessing the Internet and ICTs (Bellini et. al, 2010). It is evident that computer availability and Internet access have improved over the last several years; however, within the 2016 Broadband Progress Report, the Federal Communications Commission (FCC) stated that the digital divide continues to widen, especially in terms of broadband Internet access:

> There continues to be a significant disparity of access to advanced telecommunications capability across America with more than 39% of Americans living in rural areas lacking access to advanced telecommunications capability, as compared to 4% of Americans living in urban areas, and approximately 41% of Americans living on Tribal lands lacking access to advanced telecommunications capability. (p. 3)

Agarwal et al. (2009) reported that although access to the Internet is a result of individual circumstances, access to the Internet and ITC is subject to social influence coming from geographic areas and interactions with those who currently have access. The study concluded access and usage are influenced by local patterns and peer effects. An example of peer effects or social influence would be technology adoption and access in a school setting (Middleton &

Chambers, 2010). Becker (2007) studied digital access and use equality in education using data from the National Assessment of Educational Progress (NAEP) state assessments from 70,382 students in 3,479 schools and 40 states. The report stated schools with computer labs likely increased computer usage. Data also showed rural schools and schools with higher populations of African American students had less access to computers.

Behavioral Limitation

Behavioral limitations refer to an individual's inability to fully apply technology skills regardless of the level of usage capabilities (Bellini et al., 2012). Limitations can be barriers such as beliefs, attitudes, and intentions that can result in negative behaviors toward ICT. Examples of negative behaviors toward ICTs are using ICTs for leisure during work (cyberslacking) or routine-preserving behavior (also known as resistance to change) (Bellini et al., 2012).

Thompson (2013) studied the technology use patterns and approaches to learning of digital natives. The term "Productive Learning Habits" refers to cognitive behaviors associated with learning, such as focusing attention and critical thinking and processing and the ability to be flexible and learn from a variety of different situations (e.g., lecture, project work, etc.). Participants with high scores on "Rapid Communication Technology" use (texting, social media use, chatting), microblogging (updating Twitter or other microblogging sites), and multimedia creation (creating and editing digital images and videos) tended to have lower "Average Productive Learning Habits" scores. Those with higher Book Reading (reading books for enjoyment or learning) scores had higher Productive Learning Habits scores (Thompson, 2013).

Student attitudes, motivation, and perception affect student performance. Michinov et al. (2011) studied virtual learners in a 10-week course and found a negative relationship between procrastination and performance. Procrastination was a result of a lack of motivation to work on

the course or wanting to drop out of the course. Fredrickson's (2018) study compared the impact of student effort and content interaction for on-campus and virtual learners in a junior-level business course. Student behaviors included student preparation; student perception of working hard; and student engagement, skill, and participation. Students who actively participated in their classes spent hours preparing positively related to student learning (Fredrickson, 2018).

Finnegan et al. (2008) studied student behavior in 118 sections of 22 general education virtual courses over 3 semesters. Students who completed courses engaged in all virtual activities more frequently with more amounts of time than unsuccessful, withdrawing students. Students that completed the virtual courses were found to engage virtual learning activity longer and more frequently than those who were unsuccessful and withdrawn. The motivation was determined to be the main factor of withdrawal. After being in the course for a limited time, students were not motivated to overcome supposed difficulties with technology, course expectations, and academic factors (being underprepared) to complete the course (Finnegan et al., 2008). The assumption is that students who are saturated with technology should be able to do and perform well. However, there are several behaviors on and offline that affect effectiveness. Student perceptions of the course work, motivation to complete tasks, and overall interest in active tasks using technology in virtual environments can create behavioral limitations (Finnegan et al., 2008).

Cognitive Limitations

Cognitive limitations are defined as an individual having insufficient digital skills needed to effectively use ICT (Bellini et al., 2010). Cognitive limitation refers to difficulties in one's educational background, information processing and critical thinking capabilities, and hands-on experience using ICT that weaken the potential use of ICTs (Bellini, 2018). In 2010, Goode's study found that sociocultural influences develop user's identities with technology. Those

identities could promote academic and social opportunities if used properly. Zickuhr (2013) presented findings showing that 10% of American adults 18 and older participating in his study said frustration was why they do not use the Internet or email. Eight percent of the 357 people surveyed cited they did not have functioning Internet skills. Overall, a total of 32% cited reasons tied to usability as to why they do not use the Internet. Barzilai-Nahon (2006) said that "readiness for use" and "awareness" indicate the initial belief of the user to use of technology. Cognitive limitations can have a direct effect on the user's belief or attitude toward ICT and how he/she uses it. This study focuses on computer self-efficacy to measure cognitive limitations.

Computer Self-Efficacy

Self-efficacy refers to an individual's belief (confidence) about his or her capabilities to execute a specific task (Stajkovic & Luthans, 1979). Self-efficacy is not a measurement of skill; rather, it reflects what individuals believe they can do with the skills that they own (Eastin & LaRose, 2000). An extension of self-efficacy is computer self-efficacy.

Computer self-efficacy is the belief and attitude of an individual's ability to perform a task using computers (Compeau & Higgins, 1995). According to Eastin & LaRose (2000), the correlation between self-efficacy and personal computer use is perhaps automatically obvious. Staples et al. (1998) found those with high levels of self-efficacy in remote computer situations were more productive and satisfied, and better able to cope when working remotely. Experiences differ in the individual's assessment of computer self-efficacy and the differences affect motivations that drive individuals to search for the skills needed to use technology (Tzeng, 2009). Individuals with higher computer self-efficacy seem to work more diligently and longer on tasks (Torkzadeh & Van Dyke, 2002).

Sam et al. (2005) tested 81 female and 67 male undergraduate students at a Malaysian university. Students were measured on their computer self-efficacy using the computer self-efficacy scale and their computer anxiety using the computer anxiety scale. The Internet scale was used to measure students' attitudes toward the Internet. The article concluded that those tested had moderate computer anxiousness, medium attitudes toward the Internet, high computer self-efficacy, and used the Internet mostly for educational purposes such as doing research, downloading electronic resources, and e-mail communications.

Wangpipatwong et al. (2008) tested 1st-year university students from Bangkok to examine whether computer self-efficacy, Internet self-efficacy, and computer anxiety were related to students taking a computer course virtually. Results showed this course was more efficient and raised student's computer self-efficacy, Internet self-efficacy, and computer attitude. Another article observed high computer self-efficacy (a) reduced the strength and significance of the impact of anxiety on perceived ease of use and (b) having a Bellini's relationship with computer anxiety (Saadé & Kira, 2009).

Bellini et al. (2016) surveyed undergraduate students in Brazil who used ICT academic systems to determine the relationship between computer self-efficacy and anxiety as a cognitive limitation. Anxiety levels describe the hesitation about using ICTs and computer self-efficacy shows how confident the user is in doing a task using ICTs. High levels of anxiety and low levels of computer self-efficacy usually represent important limitations, since they may reveal that the individual is not cognitively prepared for the ICT-mediated task. High computer self-efficacy levels could also be a cognitive limitation because the individual's confidence may be unrealistically high. Extremely low anxiety could mean the individual is not adequately engaged in the task. This study found high levels of computer self-efficacy and the low levels of anxiety

could be an explanation for the nonsignificant system use or an important cognitive digital limitation.

Digital Effectiveness

Digital effectiveness is the user's adoption of digital resources to appropriately use them at their maximum levels (Barclay & Duggan, 2008). This is an expanded view of Warschauer's (2002) recommendation that to effectively use ICT to access, adapt, and create knowledge is a repetitive relationship among physical, digital, human, and social resources. Bellini's (2018) definition of digital effectiveness reviewed individual ICT users instead of groups of people and their levels of purposeful ICT use that they achieved. Bellini believed digital effectiveness is measured by the result of digital capabilities and limitations in terms of access, behavior, and cognition. This concept is dependent on the individual's purpose and being able to use ICT in desirable ways, whether they master it or not (Bellini, 2018).

Information System Success Model

The Information System (IS) Success Model was used to test and measure digital effectiveness in this study. The original model, based on Mason's Modification of Shannon and Weaver's Model of Communication, includes three levels of information: the technical level, the semantic level, and the effectiveness level (Shannon & Weaver, 1949). Mason adapted the original model and extended the effectiveness level to include receipt of information, influence on the receipt, and influence on the system (1978). The updated model consists of six constructs that together explain the effectiveness of ICT: system quality, information quality, service quality, intention to use, user satisfaction, and net benefits (Delone & McLean, 2003).

Harrison (2005) tested ICT effectiveness use in volunteers using the IS Success Model. The data showed the differences in the rate of adoption could be explained by differences in the

attitudes and expectations volunteers and managers had about ICT and several factors that were associated with the development of them. Results also showed there were differences in access, with the regional group falling behind the enabled group regarding physical access to ICT components. Findings also showed volunteers that used more ICT for volunteer work were more engaged compared to those that used traditional methods to perform tasks. Another interesting finding was that volunteer managers played a significant role in capabilities and access (Harrison, 2005).

Using the Information System Success Model, Zheng and Liang's (2017) included "users" ability accesses and "skills ability access" to the existing model to explain the relationship between a new information technology application and its impact on educational equality. This study defined the digital divide as "the differences existing in the opportunity of using new IT (cloud computing, Internet of things, and big things) between information haves (IH) and information have-nots (IHN)" (Zheng & Liang, 2017, p. 3588). The study's results showed system quality, information quality, and service quality of new IT has a direct effect on user's ability to access, further affecting user's intention to use and user's satisfaction, and then influence the apprehension of educational equality (Zheng & Liang, 2017).

Summary

Virtual learning in K-12 has and will continue to grow to meet the needs of today's learners. Research shows the many benefits of virtual learning on the K-12 level. Research also shared the notion of learner characteristics that are needed to help students succeed in a virtual learning environment. Research on the digital divide has shifted and changed since the term was introduced in the late 1990s. Although research has reviewed how virtual learning can be beneficial to the student, literature has shown a causal link between digital access, digital

capabilities, and digital outcomes. These levels of the digital divide can cause students to seem to be codependent to each other. Because of the disproportionate number of those who have access to those that do not, virtual learning can possibly dispel or lessen the digital divide among those who learn in a virtual environment. However, Bellini introduced a more modern way to view the digital divide as digital limitations.

Digital limitations in access, capabilities, and behavior focus on the individual users' relationship with technology. Limitations in the users' access, behaviors using technology, and cognitive computer self-efficacy all influence the user's adoption of resources to appropriately use them effectively or digital effectiveness. Using the Information System Success Model to measure digital effectiveness and test constructs that together explain the effectiveness of ICT: system quality, information quality, service quality, actual user satisfaction, and performance impact.

CHAPTER III

METHODS

Virtual learning continues to become commonplace as instructors and educators recognize that learning does not just have to take place in the traditional face-to-face classroom setting (Sitzmann et al., 2006). As virtual learning has increased in popularity, there is a need for research to better understand the inequities virtual students may face. The purpose of this study was to examine how digital limitations (access, behavioral, and cognitive) impact the digital effectiveness of secondary level students enrolled in a virtual learning environment. This study examined how access limitations of Internet and computer technology, cognitive limitations of personal experiences and capabilities, and behavioral limitations of personal attitudes and motivations affect the digital effectiveness of their virtual learning experience. By understanding the digital (access, behavioral, and cognitive) limitations of virtual learners and how they impact their digital effectiveness can help stakeholders make crucial decisions on the purchase and use of technology in communities and schools. School administrators can accommodate the shift of technology culture in school and classrooms by understanding the importance of the additional resources needed for the support and success of virtual students. It is important to understand that digital limitations correspond to digital effectiveness. These limitations affect the perception, attitudes, and beliefs of learning in a virtual environment as well as student performance and learning outcomes.

Research Question

Data collected examined the following research question:

1. Is there a relationship among demographic factors, digital limitations, and digital effectiveness?

Setting

Participants of this study were online students enrolled in the Alabama State Department of Education's (ALSDE) supplemental statewide virtual learning program. This statewide virtual learning program is available to the over 300 school districts, which includes over 20,000 middle, junior, and senior high schools for grades 7-12. The ALSDE course of study standards and objectives are used to create course content for all virtual courses. Therefore, courses in the online environment are equivalent to traditional face-to-face classes. This program offers over 120 courses during the academic school year and 40 courses during the summer in all core subjects. Advanced Placement, credit recovery, and credit advancement courses are also available.

Total state program enrollments for the 2019 school year were 22,634 students. Gender data show that 54% of the enrolled students were female and 46% were male. Ethnicity data show 66% of enrolled students were White, 28% were African Americans, 3% were American Indian/Alaskan Native, 1% were Asian, less than 1% were Native Hawaiian/ Pacific Islander, and less than 1% identified as Multirace. Socioeconomic demographics are categorized by family income data that are requested every year. This information identifies students who are eligible for free, paid, or reduced lunch prices. Forty-nine percent of students of program participants paid full price for lunch; 43% had free lunch provided, and 8 % paid reduced prices for lunch. This study focused on students who were 18 years and older taking a course within the

statewide virtual program. There were 1,705 students who were 18 years old and older in the state that were enrolled in the statewide virtual program in 2019. This subpopulation was diverse in terms of socioeconomic status, race, and whether they lived in rural, urban, and suburban areas. Forty-two percent of the enrolled students who were over the age of 18 were on free/reduced lunch and 45% of students paid full price.

The virtual learning program is a mostly asynchronous program that works on an "Any Time, Any Place, Any Pace" model. Students taking courses in the virtual learning environment can access their course content and assignments through the learning management system at any time, any place, at their own pace. Students can work independently at their Local Education Agency (LEA) during normal school hours, or with onsite facilitators that are available to assist them. Onsite facilitators maintain daily contact with teachers regarding student progress, address issues that may arise, and provide resources and assistance to students. Students are required to take the end of the unit and end of term exams with their onsite facilitator at their LEA. Students average two online courses per semester based on their individual schedule needs and the schools' course offerings.

Courses include core subjects such as English, Social Studies, Science, Math, and Foreign Languages, as well as electives in Career Technical subjects and Health. The statewide program employs around 886 adjunct faculty who have State of Alabama teaching certification. These teachers have 3 or more years' experience in their teaching fields in various school systems in the state.

The virtual learning program provides resources and technical assistance through regional support centers located in the northern, central, and southern areas of the state. The support centers provide training for facilitators and online teachers as well as facilitating student

orientations when schools request them. The course development team builds course content into course shells and provides additional technical resources and assistance for teachers and students within the course. For example, there is a student technology resource section in every course. This resource section answers frequently asked questions including how to use Google Docs, how to save documents to PDFs, and other troubleshooting instructions.

Sample Selection

This statewide virtual program was selected for this study for several reasons. First, a program that offers courses through a virtual learning environment was needed. Second, a program that served students on a secondary level in the state was required. This program has a long history with the public school system and has been in use for over 10 years. Last, a program that served a diverse group of students with varied school environments and cultural backgrounds was needed to evaluate socioeconomic influences.

Students who were 18 years old and older and enrolled in the statewide virtual program were the primary sample. This age group did not require parental permission and provided their own consent to participate in this study. Most students in this age group would have taken one or more courses in this virtual learning environment. Therefore, a minimal risk for this group was anticipated.

Instrumentation

The construct instrument measured the following constructs:

- Demographics (5 questions)
- Access Limitation (7 questions)
- Behavioral Limitation (10 questions)
- Cognitive Limitations/Self- Efficacy (7 questions)
- IS Success Model (24 questions)

The demographic section was adopted from the Wei et al. (2011) instrument. Three demographic questions (Demographic Section, Questions #2, #3, and #4) were added to get a better description of the participants. Participants were asked if they received free lunch or paid full or reduced prices for lunch (Demographic Section, Question #3). Also, survey participants were asked to select the ethnicity they identified themselves as (Demographic Section, Question #2). Students were asked which school they attended (Demographic Section, Question #4). This question helped to identify the community and size of school. Last, students were asked in what grade they had their first encounter with a virtual class (Demographic Section, Question #5).

The measures for access limitations were also adopted from Wei et al.'s study (2011). The original questions came from the Usage of Home Access and School Technology, Resources and Usage sections. In the modified construct, those questions were placed in the Access Limitation section. Questions were added and reworded to ensure participants understood the questions and gather additional information on access to the Internet and technology. A question was added to ask if the student had Internet access at home (Access Limitation Section, Question #2). This question was a follow-up question to the user computer home access. The original Measurement of Construct instrument asked about the student-to-computer ratio in the computer classroom (School IT Resources Availability/Question #1 for Original Measurement of Construct). This question was reworded to ask how many computers are in the computer lab. Instead of a blank for a number, that was changed to ranges from 0, 1 to 10, or 11 or more (Access Limitation Section, Question #5). A follow-up question was added to ask if there were enough computers in the computer lab for all the students to use at once (Access Limitation Section, Question #6). This gave insight into the computer lab's environment and school access to technology.

The behavior limitations section was adopted from Schommer-Aikins and Easter's (2018) study. Questions were pulled that would form the original 74-question study that measured online self-directed learning, cognitive flexibility, and procrastination. The modified section included 10 questions that the students better comprehended to get a valid answer.

Information System Success Model was measured using the original survey from Aldohlay et al.'s (2018) study. This construct included an extension to include self-efficacy. This section was used to collect data on cognitive limitations. Additional questions were adopted from Bellini et al.'s (2016) study. The original construct tested computer self-efficacy as a cognitive limitation. Questions were deleted from the original study to ensure students' valid responses and comprehension. Questions that were used were targeted for the use in this study. The complete Modified Measurement of Construct instrument that was given to the students can be found in Appendix A. The modified survey had five sections with 53 questions and took about 1 hour for the students to complete.

Original Instrument Validity and Reliability

Validity refers to the "extent to which a test actually measures what it was intended to measure" (Nolan & Heinzen, 2011, p. 8). Reliability is defined as "the consistency of a measure" (Nolan & Heinzen, 2011, p. 8). Wei et. al's (2011) study was assessed for discriminant and convergent validity and reliability. A principal component analysis was conducted to assess discriminant validity. Convergent validity, the extent to which multiple questions measuring the same construct agree (Cook & Campbell, 1979) was measured using Cronbach's alpha (Nunnally, 1978). All constructs had Cronbach's alphas exceeding 0.70. These results indicated that the constructs in this study had adequate discriminant and convergent validity (Wei et.al, 2011). In Hsu and Chiu (2004), the measurement model included the estimation of internal

consistency and the convergent and discriminant validity of the instrument items. The reliability measures were well above the recommended level of 0.70, thus indicating adequate internal consistency (Hsu & Chiu, 2004). The measurement used from the Schommer-Atkins and Easter study (2018) showed all key variables were studied for internal reliability (Cronbach alpha) and skewness. No variables were skewed above 1.0 (Schommer-Atkins & Easter, 2018). No variables with test-retest reliability were shown above 1.0 (Schommer-Atkins & Easter, 2018).

For the Aldohlay et al. (2018) study, construct validity and reliability were used to test the measurement. Cronbach's alpha coefficients were evaluated to determine the reliability of all the core variables in this study's measurement scheme. The value of every individual Cronbach's alpha coefficient in this research fell between 0.818 and 0.959, which exceeds the suggested value 0.7 (Kannana & Tan, 2005; Nunnally & Bernstein, 1994). Additionally, the value of every composite reliability factor fell between 0.905 and 0.965, which exceeds 0.7 (Gefen et al., 2000; Solomon et al., 2015; Werts et al., 1974). Therefore, the construct reliability and Cronbach's Alpha were relatively error-free for all the constructs (Aldohlay et al., 2018).

Study Procedures

In order to receive approval to use public school students statewide as study participants, an abstract with a description of the study was sent to the ALSDE's Educational Technology Department's leadership. Program leadership and the legal department reviewed this information and approval was granted upon conditions. The conditions were a list of students to engage as study participants would not be provided to the researcher and a raffle for incentives could not take place. Upon ALSDE's approval and support (Appendix B), the Institutional Review Board (IRB) application was made and approved (Appendix E).

To assist in recruitment, a description of the study and the Qualtrics survey link were sent to the educational stakeholders at Local Education Agencies, educational programs that served similar populations, and teachers. Using student demographic data, student participants who were 18 years old or older were engaged using the Desire2Learn (D2L) Learning Management System. Recruitment emails (Appendix D) including the purpose of the research, eligibility criteria for the study, the time required of participants, and the Qualtrics survey link were sent to the students' D2L email addresses. Consent was obtained before the start of the survey (Appendix E). No identifying information was collected in the survey. Students remained anonymous.

Data collection was conducted from June 2020 until January of 2021. Grading periods in this timeframe included first and second summer terms, first fall 9-week block, second fall 9-week block, traditional spring 18-week semester, and traditional all year courses. Efforts to engage potential participants continued with sending a total of six rounds of emails through D2L. A total of 332 participants were recruited with 175 (52%) completing the entire survey.

Data Analysis

Quantitative data were analyzed using JMP© Software. A significance level of .05 was used for each analysis. The research question, is there a relationship among demographics, digital limitations, and digital effectiveness in a virtual learning environment, was answered by contingency analysis, chi-square of independence, logistical regression, Pearson's correlations, and bivariate analysis. To determine the relationship between demographics and access limitations, contingency analysis was used. A chi-square test of independence was performed to examine the relationship between School Area Classification and School Technology Culture. Relationships among demographics, access limitations, and behavioral limitations were

measured by using logistic regression. Bivariate analysis was used to test the relationship between behavioral limitations and cognitive limitations. Correlations between the IS Success Model were tested to measure digital effectiveness. Logistic regression was used to test dependent variables to independent variables (IS Success Model categories). Table 2 presents the methodology used to answer each section of the research question.

Table 2

Data Management Table

Research Question	Measure(s) Survey Question(s)	Independent or Grouping Variable(s)	Dependent Variable(s)	Analysis
1	Demographics Questions 1-5 Access Limitations Questions 1-7	Demographic Variables	Access Limitations	Contingency Analysis
	Demographics Questions 1-5 Access Limitations Questions 1-7 Behavioral Limitations Questions 1-10 Cognitive Limitations Questions 1-7	Demographics Variable Access Limitations Cognitive Limitations	Behavioral Limitations	Logistic Regression Bivariate Analysis
	Demographics Questions 1-5 Access Limitations Questions 1-7 Behavioral Limitations Questions 1-10 Cognitive Limitations Questions 1-7	Demographics Variable Access Limitations Behavioral Limitations	Cognitive Limitations	Logistic Regression Bivariate Analysis

	Demographics Questions 1-5 Access Limitations Questions 1-7 Behavioral Limitations Questions 1-10 Cognitive Limitations	Demographics Variable Access Limitations Behavioral Limitations Cognitive Limitations	IS Success Model	Correlations Logistic Regression

CHAPTER IV

RESULTS

The purpose of this study was to examine how digital limitations (access, behavioral, and cognitive) impact the digital effectiveness of secondary-level students enrolled in a virtual learning environment. Specifically, this study sought to examine how one's access to Internet and computer technology, behavioral limitations of personal attitudes and motivations, and cognitive limitations of personal experiences and capabilities affect the digital effectiveness of their virtual learning experience. The IS Success Model was used to measure digital effectiveness using questions from Aldohlay's 2018 study. This chapter presents the results of the study. A descriptive analysis of the sample of virtual learning students is presented, followed by the findings for the research question.

Student Sample Demographics

A total of 331 survey participants attempted the Modified Measurement of Construct survey. Two hundred eighteen students agreed to participate in the study and reached the end of the survey. Twenty-two students did not agree to participate. Of the 218 students who agreed to participate in the study, 175 completed the survey in its entirety. Out of the 175 students who completed the survey, 112 were female (64%) and 63 (36%) were male. Study participants were primarily White students (n= 107, 60%) receiving free school lunch (n=99, 54%). To measure school size, schools are classified by the average daily enrollment numbers issued by the Alabama State Department of Education. The classifications go from the smallest, 1A, to 7A which is the largest. The mode of students who responded go to a 6A school, which indicates

they attend a school whose daily enrollment numbers are between 375-566 students. On average, students began taking their first online course in grade 11 (*SD= 1.32*).

Table 3

Demographics Statistics for Students

		n	%
Gender			
Male		63	36
Female		112	64
Ethnicity			
American Indian/Alaskan Native		7	4
Asian		6	3
Black		30	17
Hispanic		10	6
Multi-Race or Two or More Races		15	9
White		107	61
Lunch Costs			
Free Lunch		99	54
Reduced Lunch		14	8
Full Price Lunch		66	38
School Classifications by Enrollment	Mo= 6A		
1A		12	7
2A		13	7
3A		20	11
4A		29	17
5A		28	16
6A		39	22
7A		34	19
Grade First Virtual Course Taken	M= Grade 11 (*SD*= 1.3)		

Research Question

Is there a relationship among demographic factors, digital limitations, and digital effectiveness? This research question sought to identify whether certain variables are related to access, behavioral, and cognitive limitations individually and whether these grouped variables have a relationship on how effective students are in a virtual learning environment.

Access Limitations

Descriptive Statistics of Access and Use

To determine if there were access limitations, survey respondents were asked questions about their ownership and use of computer and wireless internet access at home and school. Results measured two indicators, which were home access and use. While most survey participants had home computer access to ICT (n=155, 89%) and wireless Internet services (n=165, 94%), how much they used home computers and the Internet varied slightly. Most study participants used a computer an average of 1-10 hours per week for schoolwork (n=118, 67%) and leisure activities such as games, emails, etc. (n=81, 75%). Table 4 provides descriptive statistics for home computer access, wireless Internet access, and computer use.

Table 4

Descriptive Table of Students' Home ICT Access and Use

	n	%
Home Computer Access		
No	20	11
Yes	155	89
Home Wireless Internet Access		
No	10	6
Yes	165	94
Computer Use for School Work		
0	14	8
1-10 hours	118	67
12 or more hours	43	25
Computer Use for Leisure		
0	50	25
1-10 hours	81	46
12 or more hours	44	29

Relationship Between Demographics and Access Limitations

For this study, the independent demographic variables were students' gender, ethnicity, school lunch costs, and school classification. Contingency analysis was performed to investigate the relationships between demographic variables and home computer access and wireless Internet. Chi-square results showed that there was an insignificant relationship between gender and home computer access, X^2 (1, N = 175) = 3.5, p = .06, and wireless Internet access, X^2 (1, N = 175) = 3.1, p > .05 (see Figures 2 and 3). As for computer use, results found significant relationship between gender and computer use for schoolwork, X^2 (1, N = 175) = 12.3, p = .002 and leisure activities, X^2 (1, N = 175) = 16.8, p = .0002 (see Figure 4 and 5). Post hoc comparisons of gender by home computer use revealed female students' use of home computer for schoolwork was statistically similar when compared to home computer use for leisure. In comparison, most males used home computers for leisure for an average of 12 or more hours per week.

Figure 2

Mosaic Plot of Home Computer and Wireless Internet Access by Gender

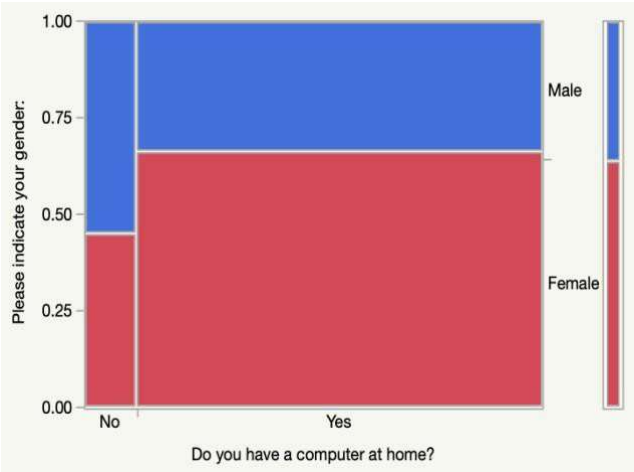


Figure 3

Mosaic Plot of Home Wireless Internet Access by Gender

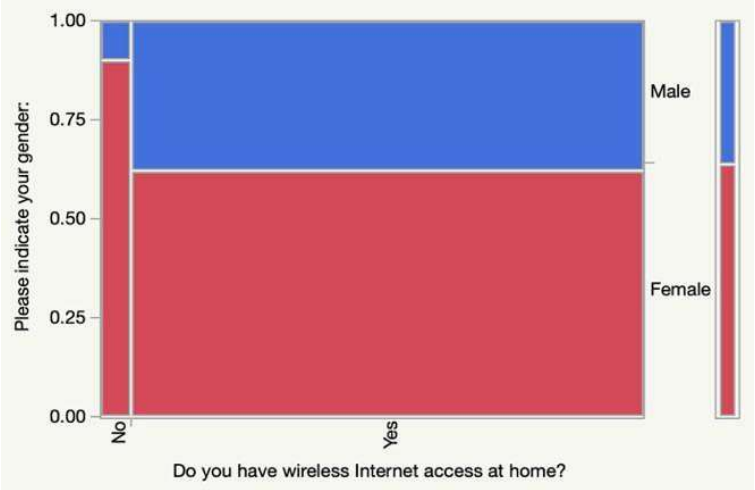


Figure 4

Mosaic Plot of Home Computer Use for Schoolwork by Gender

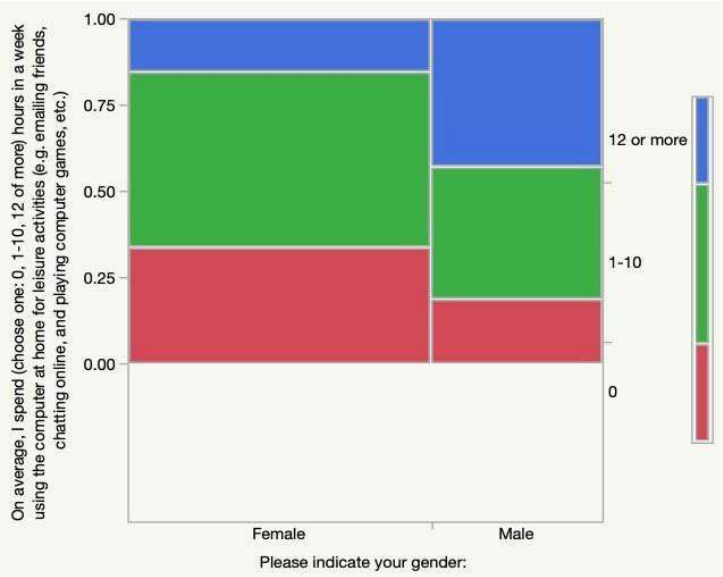
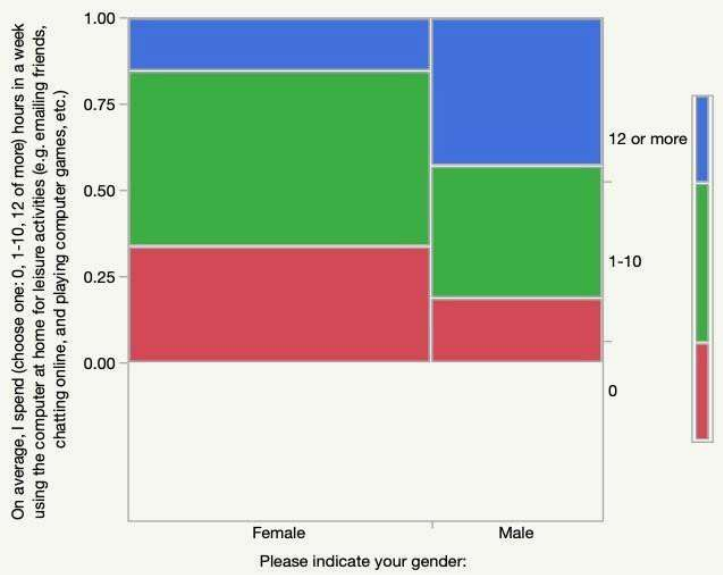


Figure 5

Mosaic Plot of Home Computer Use for Leisure by Gender



Results of a chi-square analysis found insignificant relationships between ethnicity and home computer access, X^2 (5, N = 175) = 6.7, p = .23; wireless Internet access, X^2 (5, N = 175) = 5.4, p = .35; computer use for schoolwork, X^2 (10, N = 175) = 12.7, p = .23; and computer use for leisure, X^2 (10, N = 175) = 15.4, p = .12 (see Figures 6, 7, 8, and 9).

Figure 6

Mosaic Plot of Home Computer Access by Ethnicity

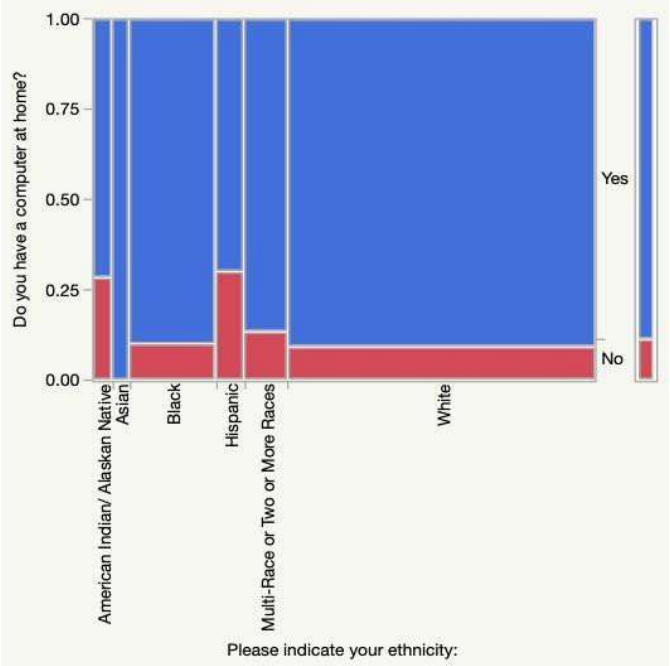


Figure 7

Mosaic Plot of Wireless Internet Access by Ethnicity

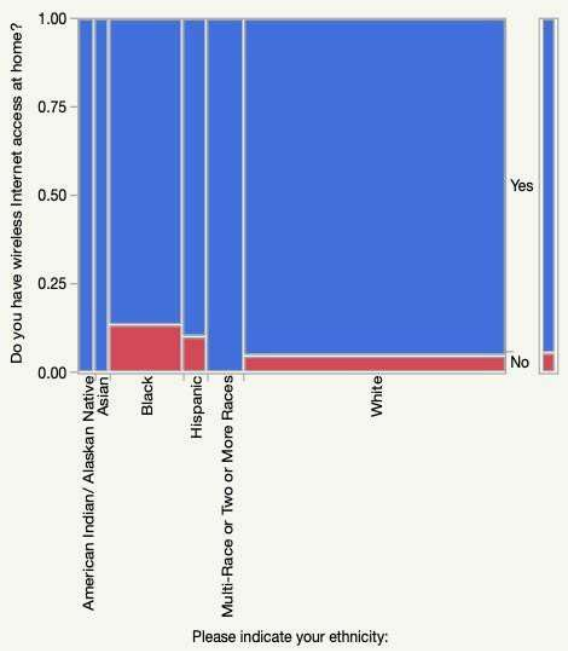


Figure 8

Mosaic Plot of Home Computer Use for Schoolwork by Ethnicity

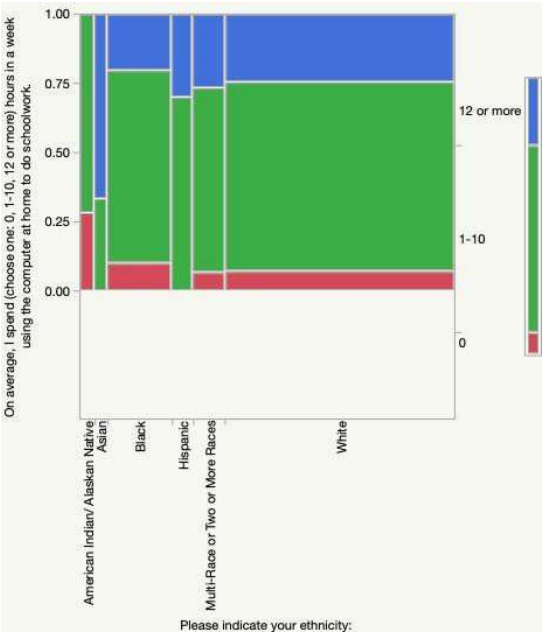
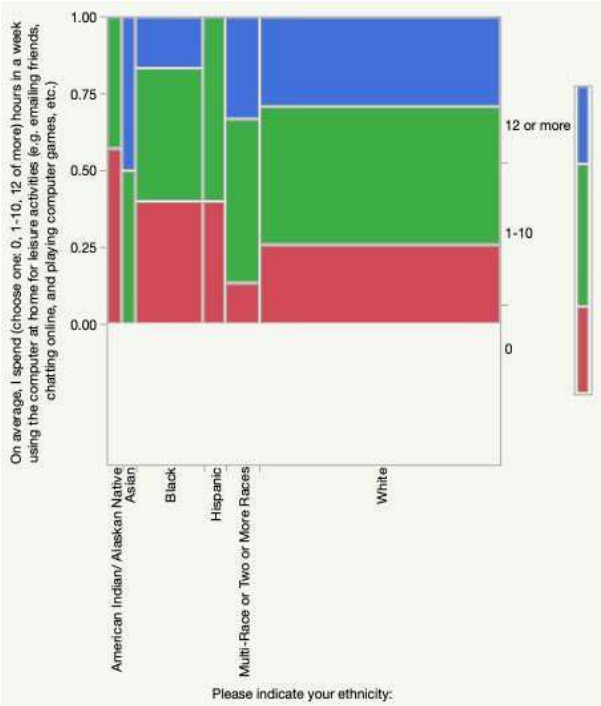


Figure 9

Mosaic Plot of Home Computer Use for Leisure by Ethnicity



There was a significant relationship found between what students paid for lunch and home computer access, X^2 (2, N = 175) = 8.77, p = .01; and computer use for leisure, X^2 (4, N = 175) = 30.1, p < .001. However, there were insignificant relationships between lunch costs and wireless internet access, X^2 (2, N = 175) = 1.4, p = .47; and computer use for schoolwork, X^2 (4, N = 175) = 5.5, p = .23. Post hoc comparisons revealed that students who paid full price and reduced prices were more likely to have computers at home. Post hoc comparisons also revealed that full and reduced-price were both statistically different where students who paid full price for school lunches were more likely to use a computer for leisure on average 1-10 or more hours per week.

Figure 10

Mosaic Plot of Home Computer Access by Lunch Costs

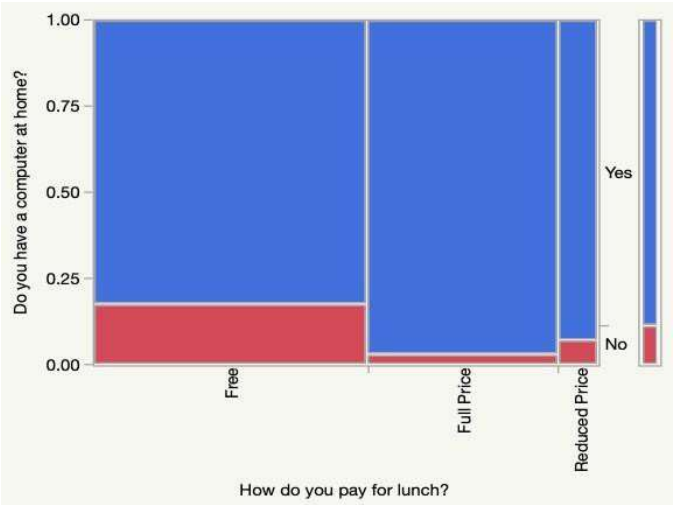


Figure 11

Mosaic Plot of Wireless Internet Access by Lunch Costs

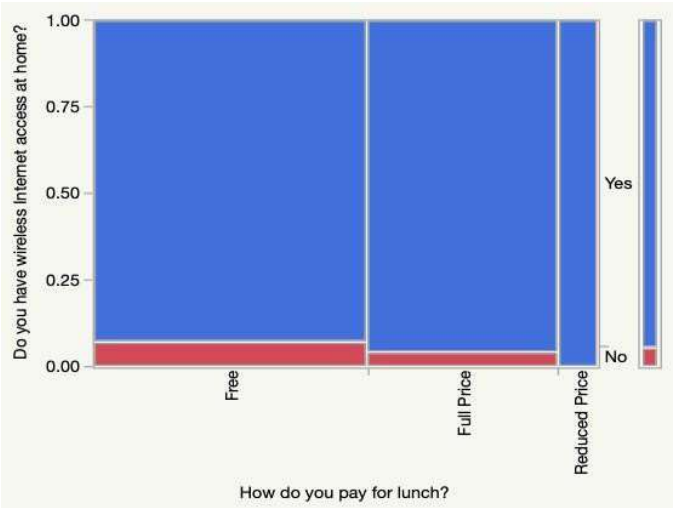


Figure 12

Mosaic Plot of Home Computer Use for Schoolwork by Lunch Costs

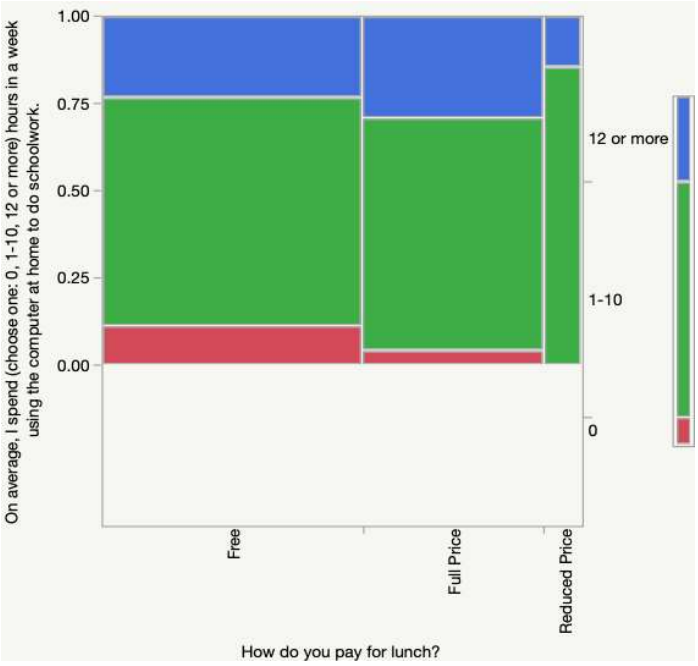
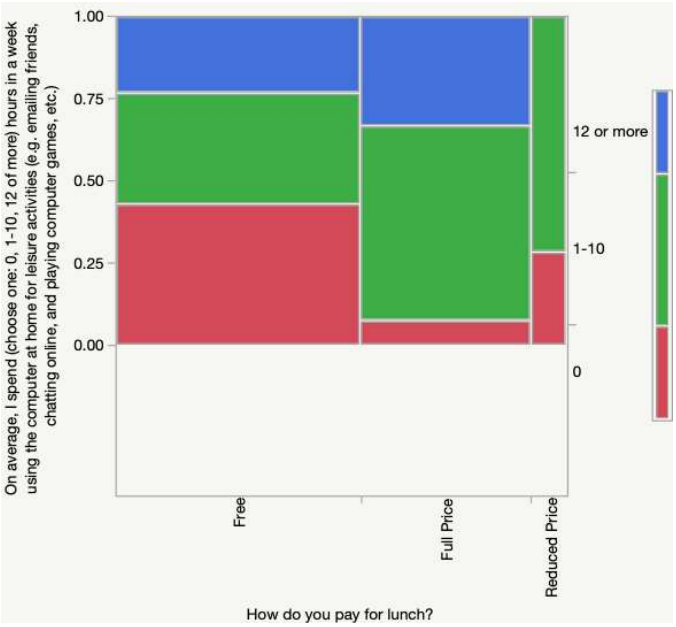


Figure 13

Mosaic Plot of Home Computer Use for Leisure by Lunch Costs



Last, school area classification had an insignificant relationship to home computer access, X^2 (6, N = 175) = 4.1, p = .66. Likewise, there was an insignificant relationship between school area classification and computer use for schoolwork, X^2 (4, N = 175) = 5.5, p = .23. Also, there was no significant relationship found between school area classification and computer use for leisure, X^2 (12, N = 175) = 10.61, p = .56. However, there was a significant relationship between school classification and wireless Internet access, X^2 (6, N = 175) = 31.1, p< .0001. Post hoc comparisons of school area classification by home wireless Internet access showed a statistical difference for students who did not have home wireless Internet access. Students who were in smaller school systems were more likely not to have wireless Internet access (see Figure 14, 15, 16, and 17).

Figure 14

Mosaic Plot Home Computer Use by School Area Classification

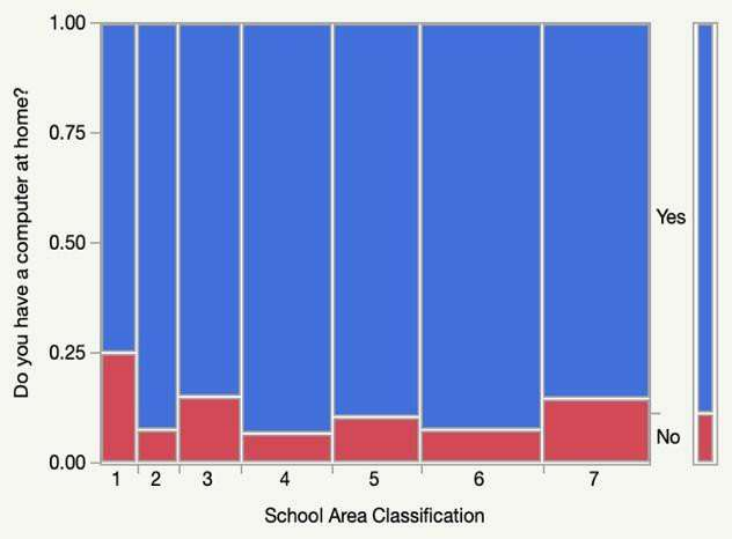


Figure 15

Mosaic Plot Home Wireless Access by School Area Classification

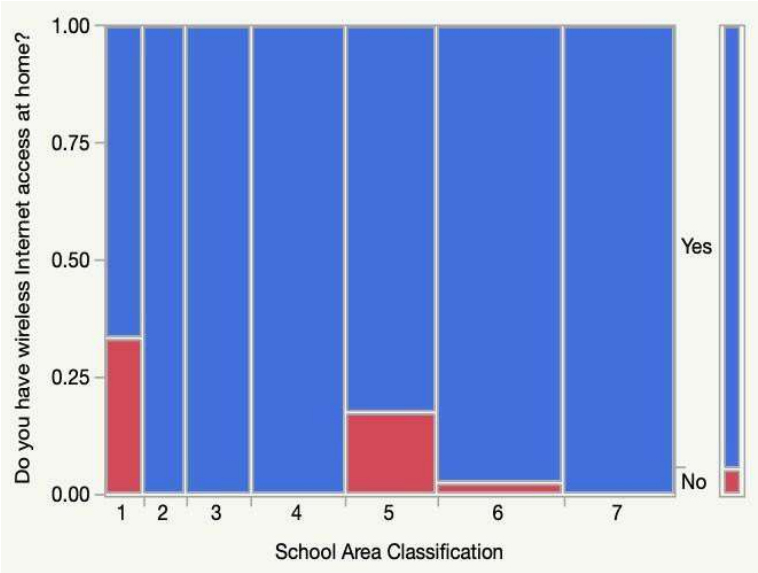


Figure 16

Mosaic Plot Home Computer Use for Schoolwork by School Area Classification

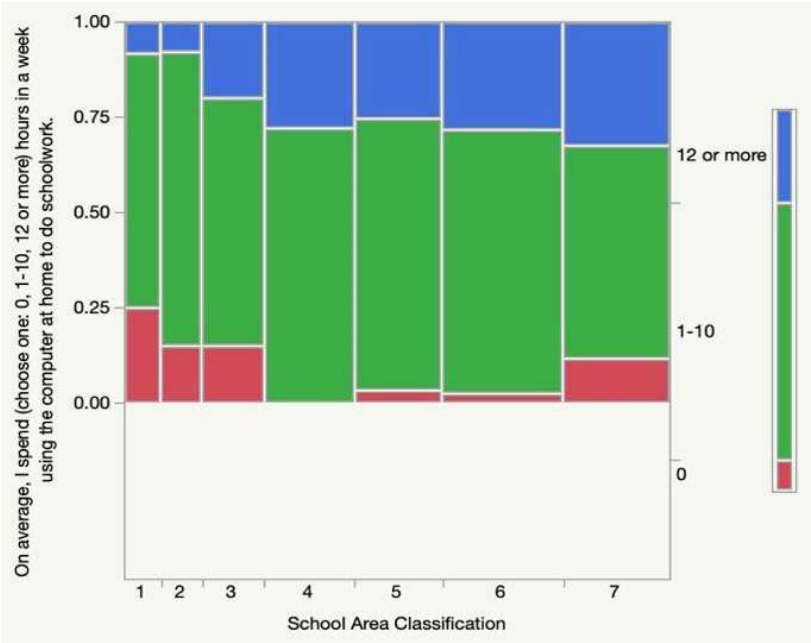
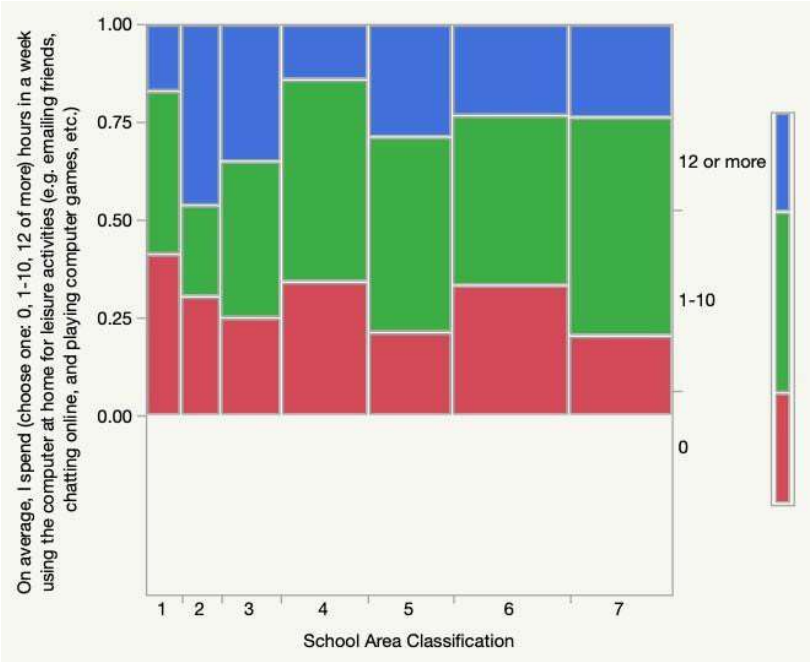


Figure 17

Mosaic Plot Home Computer Use for Leisure by School Area Classification



Descriptive Statistics of School Technology Culture

To examine survey participants' technology access and use at school, they were asked a series of questions regarding their access to school computers for their virtual learning courses and their use of ICT in school for their face-to-face courses. Most student participants felt that they had adequate access to computers at school (n=167, 95%) and spent between 1 and 4 class periods using them to complete schoolwork for their face-to-face classes (n=98, 56%). Students also reported having access to, on average, 11 or more computers in the computer labs where they participated in their virtual learning courses (n=110, 63%).

Results

A chi-square test of independence was performed to examine the relationship between School Area Classification and School Technology Culture. Results showed that there were no significant relationships between School Area Classification and the number of computers in school computer labs, X^2 (12, N = 175) = 11.7, p = .46; having enough computers for use X^2 (6, N = 175) = 8.5, p = .19; and the number of class periods used for face-to-face classes, X^2 (12, N = 175) = 16.3, p = .17 (see Figures 18, 19, and 20).

Figure 18

Number of Computers in Classroom or Computer Lab by School Area Classification

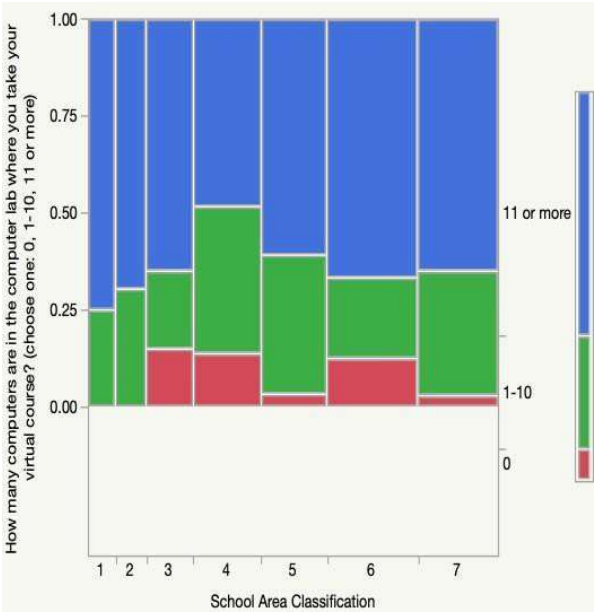


Figure 19

Computers in Classroom or Computer Lab by School Area Classification

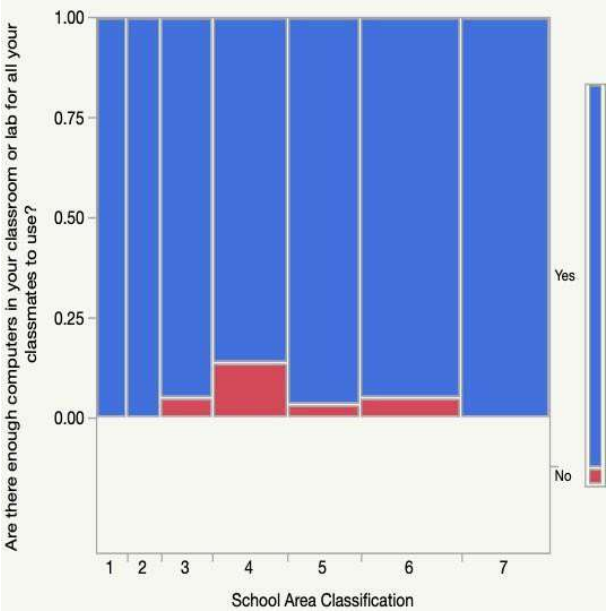
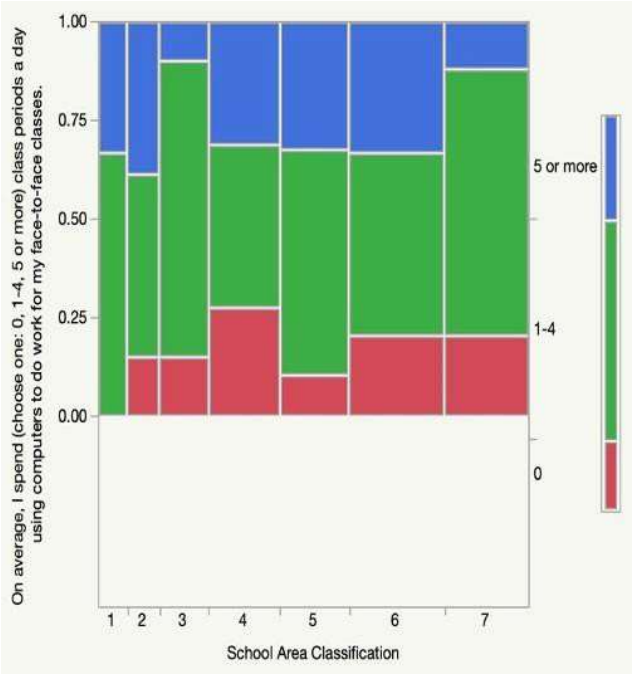


Figure 20

Number of Class Periods Spent a Day in Face-to-Face Courses by School Area Classification



Behavioral Limitations

Descriptive Statistics for Behavioral Limitations

The behavioral limitation section of the survey included 10 Likert-type questions designed to ascertain how students interacted and behaved in their virtual learning courses. Likert-type responses were in the range of 1 (Strongly Disagree) to 5 (Strongly Agree). Results showed that the mode of students' responses was either 4 (somewhat agree) or 5 (agree) for 9 out of the 10 questions provided in the survey. Question 7 represented a mode of 1 (Totally Disagree). See Table 5 for a Descriptive Statistic Table for the behavioral limitation section of the survey.

Table 5

Descriptive Table of Behavioral Limitations

#	Question	1-Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	n	%	n	%	n	%	n	%	N
1	I do not understand when I go through virtual presentations.	21%	37	26%	47	17%	29	26%	46	9%	16
2	I cannot focus on virtual presentations.	11%	19	19%	34	18%	32	31%	55	20%	35
3	I prefer to do other things than study learning materials or resources.	9%	15	9%	15	18%	32	33%	57	32%	56
4	I postpone starting things I do not like or want to do.	6%	11	11%	20	13%	23	32%	56	37%	65
5	I keep postponing my study tasks designated in a course.	16%	27	13%	22	20%	34	31%	54	21%	37
6	I do not know what to write in response to the discussion topics posted on the discussion forums.	21%	37	17%	30	21%	36	28%	49	13%	23
7	I do poorly in tests and examinations.	30%	52	20%	35	22%	39	17%	29	11%	20
8	I feel confident when taking tests and examinations.	12%	21	14%	24	17%	29	44%	77	14%	24
9	I find time to study the learning materials and/or resources in a course.	7%	13	10%	18	17%	29	45%	79	21%	36
10	I am excited about the content that I am learning.	16%	28	11%	20	14%	24	39%	69	19%	34

Results

Relationships Between Demographics and Behavioral Limitations

Logistic regression was conducted to determine if there was a relationship among gender, ethnicity, school lunch costs, and school classification and behavioral limitations. Chi-square results revealed insignificant relationship between gender and behavioral limitations, X^2 (1, N = 175) = 3.65, p = .05; lunch costs and behavioral limitations, X^2 (2, N = 175) = 3.27, p = .19; and school area classification and behavioral limitations, X^2 (1, N = 175) = .004, p = .94. Chi-square results yielded a significant relationship between ethnicity and behavioral limitations, X^2 (5, N = 175) = 13.15, p = .02. Post hoc comparisons showed in comparison to White students, Asian and Black students were found to be significant predictors. Consequently, the odds of high behavioral limitations levels were lower for Asian and Black students than those of White students.

Relationship Between Access Limitations and Behavioral Limitations

A logistic regression was used to test the relationship between access limitations and behavioral limitations. Chi-square results showed there was an insignificant relationship between home computer access and behavioral limitations, X^2 (1, N = 175) = .97, p = .32; home internet access and behavioral limitations, X^2 (1, N = 175) = 1.30, p = .25; home computer use for schoolwork, X^2 (2, N = 175) = .05, p = .9; and home computer use for leisure, X^2 (2, N = 175) = 3.55, p = .16.

Relationship Between Behavioral Limitations and Cognitive Limitations

Bivariate analysis was used to test the relationship between behavioral limitations and cognitive limitations. Results found that behavioral and cognitive limitations had a statically

significant relationship. The direction of the relationship was slight, positive slight, positive correlation, r (173) = .27, p = .0003. Therefore, the variables tended to increase together.

Cognitive Limitations

Descriptive Statistics for Cognitive Limitations

Survey participants were asked questions about their computer self-efficacy to measure cognitive limitations. These statements explored the participants' belief in the capability of doing tasks on the computer and in their virtual courses. Likert-type responses were in the range of 1 (Strongly Disagree) to 5 (Strongly Agree). Most participants answered the seven questions with a 5 (Strongly Disagree). Descriptive statistics showed the mode for most of the questions was 5 (Strongly Agree). Question 2 'I am motivated to use the learning management system' had a mode of 4 (Somewhat Agree). See Table 6 for Descriptive Statistics of the Cognitive Limitations section.

Table 6

Descriptive Statistics of Cognitive Limitations

#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	n	%	n	%	n	%	n	%	n
1	I have the needed skills to use the virtual learning management system.	3%	6	2%	4	7%	13	13%	67	49%	85
2	I am motivated to use the learning management system.	10%	18	10%	19	20%	44	41%	88	20%	43
3	I feel confident finding information by using a search engine (e.g., Google).	3%	6	4%	7	5%	8	34%	59	54%	95
4	I feel confident in the virtual learning downloading and uploading files.	4%	7	4%	7	7%	13	34%	59	51%	89
6	I am confident about how to use the tools of the new system.	8%	14	5%	9	11%	19	37%	65	39%	68
7	I am able to use the computer and its technologies.	2%	4	1%	1	3%	5	26%	46	68%	119

Results

Relationships Between Demographics and Cognitive Limitations

A logistic regression was used to determine if there was a relationship between demographic variables (gender, ethnicity, school lunch costs, and school classification) and cognitive limitations. Chi-square results showed insignificant relationships among gender, X^2 (1, N = 175) = .1.30, p = .25; ethnicity, X^2 (5, N = 175) = .6.02, p = .30; and school area classification, X^2 (1, N = 175) = .1.74, p = .18. However, lunch costs showed to have a significant relationship to cognitive limitation, X^2 (2, N = 175) = 10.8, p = .004. A post hoc

comparison showed that full-priced and free lunches significantly differed at $p < .05$. Students who qualified for free lunch were more likely to have higher computer self-efficacy levels.

Relationships Between Access Limitations and Cognitive Limitations

A logistic regression was conducted to determine if there was a relationship between access limitations and cognitive limitations. Chi-square results showed a significant relationship between cognitive limitations and home computer access, X^2 (1, N = 175) = 18.0, $p < .0001$; home wireless access, X^2 (1, N = 175) = 4.20, $p = .04$; home computer use for schoolwork, X^2 (2, N = 175) = 24.0, $p < .0001$; and the home computer use for leisure X^2 (2, N = 175) = 6.05, $p = .04$.

Post hoc comparisons showed that students who did not have a home computer and wireless Internet access were more likely to have lower computer self-efficacy levels. Post hoc comparison also found a significant difference between students who used home computers for 0 hours per week for schoolwork and those who used computers for an average of 12 or more hours per week at $p < .05$. There was also a significant difference found for students who used home computers for schoolwork for an average of 12 or more hours per week and those who used home computers an average of 1-10 hours at $p < .05$. Therefore, students who used computers on average 12 or more hours were more likely to have higher cognitive levels. Last, post hoc comparisons found a significant difference between students who used home computers for leisure for an average of 0 hours and those who spent an average of 1-10 hours per week at $p < .05$. Thus, students who spent 1-10 hours per week were more likely to have higher cognitive levels.

Digital Effectiveness IS Success Model

The Information System (IS) Success Model was used to measure digital effectiveness in this study. Survey participants answered a total of 24 questions in the following areas: system quality (3 questions), information quality (5 questions), service quality (3 questions), user satisfaction (2 questions), actual usage (2 questions), and performance impact (9 questions). Likert-scale responses were in the range of 1 (Strongly Disagree) to 5 (Strongly Agree) were for questions in five out of the six IS Success System categories, System Quality, Information Quality, Service Quality, User Satisfaction, and Performance Impact (see Table 7).

Actual use responses explored how often students logged in to their virtual courses and how much time they spent working on their courses per week. Most students reported log-in frequencies were split between several times a day (n = 65, 37%) and about once a day (n = 64, 37%). Most students spent, on average, between 2-4 hours per week (n = 43, 25%) working on their virtual class(es).

Table 7

Descriptive Statistics for IS Success System Categories Likert-Type Questions

System Quality											
#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	N	%	n	%	N	%	n	%	n
1	I find virtual learning to be easy to use.	15%	27	11%	20	13%	22	37%	65	23%	41
2	I find virtual learning to be flexible to interact with.	9%	15	9%	15	13%	22	37%	64	34%	59
3	My interaction with virtual learning is clear & understandable.	14%	24	14%	24	11%	20	35%	61	26%	46
Information Quality											
#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	N	%	n	%	N	%	n	%	n
1	Virtual learning provides up-to-date knowledge	5%	9	10%	18	12%	21	47%	82	26%	45
2	Virtual learning provides accurate knowledge	6%	10	9%	16	10%	18	38%	66	37%	65
3	Virtual learning provides relevant knowledge	5%	9	11%	19	7%	13	49%	86	27%	48
4	Virtual learning provides comprehensive knowledge	5%	9	9%	15	14%	25	47%	83	25%	43
5	Virtual learning provides organized knowledge	7%	13	10%	18	11%	19	38%	67	33%	58
Service Quality											
#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	N	%	n	%	N	%	n	%	n
1	I could use the virtual learning services at any time anywhere I want	5%	9	5%	9	15%	26	31%	54	44%	77
2	Virtual learning offers multimedia (audio, video, and text) types of of course content	5%	8	6%	10	7%	13	34%	59	49%	85
3	Virtual learning enables interactive communication	7%	13	11%	19	18%	31	36%	63	28%	49

User Satisfaction											
#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	N	%	n	%	N	%	n	%	n
1	Virtual learning was what I expected.	11%	19	8%	14	13%	23	38%	66	30%	53
2	Overall, I am satisfied with the virtual classes	15%	27	11%	20	15%	27	30%	53	27%	48

Performance Impact											
#	Question	1- Totally Disagree		2- Somewhat Disagree		3- Disagree		4- Somewhat Agree		5- Agree	
		%	N	%	n	%	N	%	n	%	n
1	Virtual learning helps me to accomplish my tasks more quickly.	17%	30	11%	19	17%	30	30%	52	25%	44
2	Virtual learning makes it easier to complete my tasks.	19%	34	12%	21	15%	27	30%	52	41%	23
3	Virtual learning improves my learning performance	24%	42	10%	18	21%	37	30%	53	14%	25
4	Virtual learning enhances my academic effectiveness	21%	37	14%	24	19%	34	29%	50	17%	30
5	Virtual learning helps reviews and eliminate errors in my work tasks	19%	34	11%	19	14%	24	34%	60	22%	38
6	Virtual learning helps me to realize my future target	23%	41	9%	16	20%	35	26%	46	21%	37
7	Virtual learning helps me acquire new knowledge	13%	22	8%	14	10%	17	38%	67	31%	55
8	Virtual learning helps me acquire new skills	14%	24	9%	15	17%	30	38%	66	23%	40
9	Virtual learning helps me to come up with innovative ideas	21%	37	10%	17	22%	38	29%	51	18%	32

Results for IS Success Model

Correlations were tested among the six categories of the IS Success model using the path outlined in Figure 21 to the responses of the students to this section of the survey. A pairwise correlation showed that System Quality had a high correlation and was significantly related to

User Satisfaction, r (172) = .75, $p < .0001$. System Quality had a low correlation to Actual Use and was highly statistically significant, r (172) = .36, $p < .0001$. Information Quality had a negligible correlation to Actual Use and was statistically significant r (172) = .23, $p < .05$. Information Quality to User Satisfaction had a high correlation and is highly significant, r (172) = .60, $p < .0001$. Actual Use had a low correlation to User Satisfaction and was highly significant, r (172) =.31, $p < .0001$. Actual Use had a low correlation to Performance Impact and was highly significant, r (172) = .37, $p < .0001$. Lastly, User Satisfaction had a high correlation to Performance Impact and was highly significant, r (172) = .77, $p < .0001$. In summary, all parts of IS Success model were found to have positive relationships with one another. Moreover, System Quality, Information Quality, and User Satisfaction were found.

Figure 21

IS Success Model Path

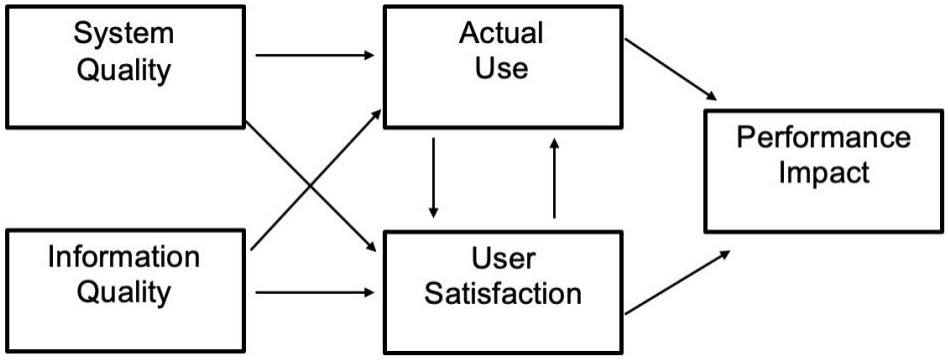


Table 8

Table of Correlations of IS Success Model Categories

	1	2	3	4	5	6
1. System Quality	--					
2. Information Quality	.67**	--				
3. Service Quality	.15*	.19*	--			
4. User Satisfaction	.75*	.60**	.10	--		
5. Actual Use	.36**	.23*	-.01	.31**	--	
6. Performance Impact	.74*	.72	.12	.77	.37**	--

*Note: *p < .05, **p < .001, two-tailed*

Relationships Between Demographics and IS Success Model

Multiple logistic regression was used to determine the relationship between demographic variables and IS Success Model. Chi-square results revealed an insignificant relationship between gender the IS Success Model, X^2 (6, N = 175) = 8.78, p = .18. Chi-square results also revealed that ethnicity had a significant relationship to the IS Success Model, X^2 (30, N = 175) = 49.09, p = .02. The individual predictors were examined further and indicated that Service Quality and Information Quality were found to be significant. Post hoc comparisons found in the Service Quality Asian and Black students to be significantly different from White students. Post hoc comparisons examining Information Quality found Asian and Hispanic students to be significantly different when compared to White students. Asian students were less likely to have higher totals of Information Quality, whereas Hispanic students were more likely to have higher measures for Information Quality. Chi-square results showed student lunch costs, X^2 (12, N = 175) = 20.80, p = .05 and school area classification, X^2 (6, N = 175) = 5.86, p = .43 had insignificant relationships to the IS Success Model.

Relationships Between Access Limitations and IS Success Model

Logistic regression was conducted to examine the relationships of access limitations (home computer access, home wireless access, home computer use for schoolwork, and home

computer use for leisure) on the categories of the IS Success Model. Chi-square results showed significant relationships were found between home computer access, X^2 (6, N = 175) = 13.44, p = .03; home wireless Internet access, X^2 (7, N = 175) = 19.10, p = .007; home computer use for schoolwork, X^2 (12, N = 175) = 35.14, p = .0004; and the IS Success Model. Results found an insignificant relationship between home computer use for leisure and the IS Success Model, X^2 (12, N = 175) = 16.97, p = .15.

Post hoc comparisons showed that students that responded *No* to having home computer access were found to be significantly different from those that responded *Yes*. Students that had access to home computers were more likely to have higher measures of system quality, which is perceived ease of use. Post hoc comparisons for wireless Internet access revealed students who responded to not having home wireless Internet were found to be significantly different from those that do. Students with wireless Internet access were more likely to have a higher measure of Information Quality, the usefulness of the system's information, and User Satisfaction. Post hoc comparisons by home computer use for schoolwork showed that students that used home computers for schoolwork on average 12 or more hours per week and 0 hours per week differed significantly at $p < .05$. Students who spend more time using computers for school see favorable characteristics of Actual Use, or voluntary use, and System Quality.

Relationships Between Behavioral Limitations and IS Success Model

Each categorical variable of the IS Model was examined to determine the relationship to behavioral limitations using bivariate analysis. Test results showed significant relationships for three variables F (1,173) = 4.4, p = .03 for System Quality; F (1,173) = 6.5, p = .01 for Information Quality; (F (1,173) = .1, $p < .0001$) for Service Quality. There was an insignificant

relationship for three variables: (F (1,173) = .1.9, *p* = .17) for user satisfaction; (F(1,173) = .03, *p* = .85) for actual use; and F(1,173) = .2.5, *p* = .11 for performance impact.

The Pearson correlation coefficient revealed a high, positive relationship between System Quality and behavioral limitations (r = .70, *p* = .03, R square = .24). There was a negligible, positive relationship between Information Quality (r = .19, *p* = .01, R square = .04). There was a perfect, positive relationship between service quality and behavioral limitations (r = 1, *p* = < .001, R square = 1), which determined that as service quality increased behavioral limitations also increased. There was a negligible, positive relationship between user satisfaction and behavioral limitation (r = .11, *p* = .01, R square = .16). There was a negligible, negative relationship between actual use and behavioral limitation (r = -.01, *p* = .85, R square = .0002). There was a negligible, positive relationship between performance impact and behavioral limitation (r = .12, *p* = .11, R square = .01).

Table 9

Bivariate Analysis for Behavioral Limitations by IS Success Model Categories

	df	Correlation Value	Regression Coefficient	F Ratio	p-value
Behavioral Limitations					
System Quality	1	0.15	0.02	4.4	0.03*
Information Quality	1	0.19	0.03	6	0.01*
Service Quality	1	1	1	.	<.0001*
User Satisfaction	1	0.1	0.01	1.9	0.16
Actual Use	1	-0.01	0.0001	0.03	0.85
Performance Impact	1	0.12	0.014	2.5	0.11

Relationships Between Cognitive Limitations and IS Success Model

Each categorical variable of the IS Model was examined to determine their relationship to Cognitive Limitations using Bivariate Analysis. Test results showed significant relationships for

all six variables (F (1,173) = 140.31, *p* = < .001) for system quality; (F(1,173) = 63.4, *p* < .001) for information quality; (F(1,173) = .13.6, *p* = .003) for service quality; (F(1,173) = .62.4, p < .001) for user satisfaction; (F(1,173) = .22.7, p < .001) for actual use; and (F(1,173) = .93.4, p < .001) for performance impact.

The Pearson correlation coefficient revealed a moderate, positive relationship between system quality and cognitive limitations (r = .70, *p* = <.0001, R square = .45). There was a moderate, positive relationship between information quality and cognitive limitations (r = .52, *p* < .0001, R square = .27). There was a negligible, positive correlation between system quality and cognitive limitations (r = .27, *p* = .0003, R square = .07). There was a moderate, positive correlation between user satisfaction and cognitive limitations (r = .51, *p* = < .0001, R square = .27). There was a low, positive correlation between actual use and cognitive limitations (r = .34, *p* = < .0001, R square = .12). There was a moderate, positive correlation between performance impact (r = .59, *p* = < .0001, R square = .35).

Table 10

Bivariate Analysis for Cognitive Limitations by IS Success Model Categories

	df	Correlation Value	Regression Coefficient	F Ratio	p-value
Cognitive Limitations					
System Quality	1	0.66	.44	140.3	<.0001*
Information Quality	1	0.51	.26	63.4	<.0001*
Service Quality	1	0.27	.07	13.6	0.0003*
User Satisfaction	1	0.51	.27	62.4	<.0001*
Actual Use	1	0.34	.12	22.7	<.0001*
Performance Impact	1	0.59	.35	93.4	<.0001*

Summary of Findings

Relationships among students' demographics, digital limitations (access, behavior, and cognition), and digital effectiveness based on the IS Success Model were studied. Study results showed most participants had access to Information Communication Technology and wireless Internet at home and, overall, responded positively to questions about the behavior and cognitive beliefs in their virtual course. Analysis of demographic variables and access limitations found there were no significant relationships between gender, ethnicity to access to home computers, and wireless Internet access. However, there was a significant relationship found as to how males and females used their computers for schoolwork and leisure. As most students participating in this study received free lunch, lunch costs also were measured to find a significant relationship between home computer access and home computer use for leisure by identifying students who qualify for full or reduced-price lunch having a statical difference from those that received free lunch.

Behavioral limitations analysis of demographic variables relationships found to have significant relationships between ethnicity and lunch costs. Lunch costs were the only demographic variable with a significant relationship to cognitive limitations. School area classification was used to measure the population size of the school each participant attends. There were insignificant relationships found to any access limitation variable. Also, no significant relationships were found between school technology culture and school area classification.

Testing relationships between digital limitations revealed access limitations were found to have a significant relationship to cognitive limitations. Behavioral and cognitive limitations had a slight, positive correlation with a significant relationship. Whereas insignificant

relationships were found between access limitations and behavioral limitations. The IS Success Model was used to measure digital effectiveness. Each category was then tested to reveal positive correlations and revealing System Quality, Information Quality, and User Satisfaction were found to be predictors of digital effectiveness.

Examining relationships between demographics, digital limitations, and students' digital effectiveness measured through the IS Success Model, results found that demographics were found to have a significant relationship to the IS Success Model with Service Quality and Information Quality being significant predictors. Access limitations were found to have significant relationships to the IS Success Model, showing that students with access to ICT and the Internet felt like the system was easy to use and information was relevant. Students who used their home computers were found to be significantly connected to Actual Use.

Behavioral limitations results were found to be positively correlated with four of the six categories with a perfect positive relationship to Service Quality and a negative correlation to Actual Use. Finally, cognitive limitations revealed high to moderate, positive correlations to System Quality, Information Quality, User Satisfaction, and Performance Impact, and positive low and slight correlations were found between cognitive limitations and Service Quality and Actual Use.

CHAPTER V

DISCUSSION OF RESULTS

A study was conducted with high school students in Alabama enrolled in the state's supplemental statewide virtual learning program. Utilizing Bellini et al.'s (2016) digital limitations (access, behavioral, and cognitive) and digital effectiveness as frameworks, the study examined how access to Internet and computer technology, behavioral limitations of personal attitudes and motivations, and cognitive limitations of personal experiences and capabilities affect the digital effectiveness in the participants' virtual learning environment. DeLone and McLean's (2003) Information System Success Model was used to determine digital effectiveness by measuring students' use, expectations, and attitudes of the six IS Model categories. Relationships between each digital limitation were explored. Differences in gender, ethnicity, lunch costs, and school area classification were tested between digital limitations. Finally, relationships between demographic variables, digital limitations, and the IS Success Model categories were explored. This chapter presents a review of the theoretical framework and a discussion of the findings of the research question. Additionally, implications for practice and further research are shared, followed by a summary of the study.

Theoretical Framework

Bellini et al.'s (2010) digital limitations, Bellini's (2018) digital effectiveness, and DeLone and McLean's (2003) Information System Success Model served as the frameworks for this study. The term "digital limitations" was used to highlight an individual and their levels of access and use of ICTs, as these individuals present three forms of limitations on the level of

access, cognition, and behavior. Access limitations explored social and material resources and access to Information Communication Technology (ICT). Behavioral limitations examined the user's experience to apply their digital abilities. Lastly, computer self-efficacy questions measured cognitive limitations and looked at the user's abilities to use ICT effectively and the user's perception of their abilities to use a computer effectively.

Digital effectiveness is the expectation that the use of technology builds on the developments in the interactions with the Internet and material access, use and skills, cognition, and intention toward the Internet and computers (Bellini, 2018). Digital effectiveness was measured by DeLeon and McLean's Information System (IS) Success Model. The IS Success Model identifies six categories that map out system success and outcomes. For this study, the Modified Measurement of Construct was used to allow students who had experiences in a virtual learning environment to answer questions about their home access and use, school use, behavioral tendencies, beliefs and attitudes, and overall experience in the virtual courses and environment. Demographic information and survey data collected for this study allowed for the results to be compared to previous limitations and for practice recommendations.

Research Question

The question which guided this study sought to determine, "Is there a relationship among demographic factors, digital limitations, and digital effectiveness in a virtual learning environment"? Demographic variables were listed as gender, ethnicity, lunch costs, and school area classification. Most of the student participants were female, White students who received free lunch. The average school area classification was a 5A school that had an enrollment of 375-566 students.

The relationships among the demographic variables of gender, ethnicity, school lunch costs, and school area classification and access limitations varied. Access limitations refer to the complications related to the lack of resources and access to Information Communication Technology and the Internet. It was evident in previous literature that computer availability and Internet access have improved over the last several years (FCC, 2016). It was also apparent in this study as most study participants reported having access to computers and wireless Internet. There were insignificant relationships found between gender and ethnicity to home computer and wireless Internet access. However, there were significant relationships found between gender and how they used home computers for schoolwork and leisure. This may be an indication of female students using home computers for schoolwork more and male students using computers more for leisure. This is not surprising as female students' use of computer technologies for study purposes has increased more than male students, while male students used ICT more frequently for exchanging information and for recreational purposes (Heldt et al., 2020).

The price students paid for lunch was used as a measurement of socioeconomic status. Previous research showed socioeconomic differences such as student lunch eligibility were a factor for public school students' access and use of computers and the Internet at home and school (Huang & Russell, 2006). While home to wireless internet access and home computer use for schoolwork were found to have no relationship to lunch costs, results of this study found significant relationships between what students paid for lunch, home computer access, and home computer use for leisure. Although most participants in this study received free lunch, students who paid the full price were more likely to have home computer access. Students with higher income levels are more likely to be able to afford and live in areas where wireless Internet service is available. Previous literature also found students who did not participate in free or

reduced lunch had access to home computers (Vigdor et al., 2014) and those students had higher levels of full-spectrum technology use (Ching et al., 2005).

Last, this study found that the size of the school did not have any impact on home computer access and use. However, as for wireless Internet access, school classification had a highly significant relationship. Results suggested students in 1A schools were less likely to have wireless Internet access at home. Smaller schools in Alabama are normally in rural areas where there is an insufficient broadband Internet connection or unaffordable expenses for Internet access at home (Zhao et al., 2010).

Previous research reported schools with computer labs likely increased computer usage (Becker, 2007). This was confirmed when School Area Classification data were tested to find relationships to how technology is perceived and used at various schools. Data analysis results showed there was an insignificant relationship between School Area Classification and the number of computers in school computer labs, having enough computers for use, and the number of class periods used for face-to-face classes. This is indicative of survey participants being in mostly larger schools where students had adequate access to computers at school and spent between 1 and 4 class periods using them to complete schoolwork for their face-to-face classes. With students' positive perceptions of the availability and quality of in-school technology, such exposure heightens positive use and self-efficacy (Wei et al., 2011).

Behavioral limitations questions were designed to measure students' behavior and attitudes in their virtual courses. When testing for relationships between demographic variables and behavioral limitations, gender, lunch costs, and home computer use for schoolwork and leisure were found to not have significant relationships to behavioral limitations. However, data analysis results yielded a significant relationship between ethnicity and behavioral limitations.

Most survey participants were White students, and minority participants were small subsections of the survey population. Study participants' self-reported overall positive responses to behavioral limitation questions results found that Asian and African American students had higher levels of behavioral limitations than White students. With the increase of home computer and wireless Internet access shown in this study, access limitations did not have a significant relationship to behavioral limitations. This is in line with prior research on student behaviors in virtual learning courses which found students who spent hours actively engaged in virtual learning courses more frequently were found to have positive behaviors (Finnegan et al., 2008; Fredrickson, 2018).

The cognitive limitations section measures students' computer self-efficacy, the belief of their capabilities to execute tasks on the computer. Survey participants mostly answered the questions positively and agreed that they felt confident using computers in tasks for their virtual learning class. Testing demographic variables to cognitive limitations showed insignificant relationships between gender, ethnicity, and school area classification. This was surprising as previous research found females and minorities tended to have lower computer self-efficacy (Wall, 2004; Wei et al., 2011). However, lunch costs were found to have a significant relationship to cognitive limitations. This falls in line with the literature. Socioeconomic factors in previous literature were shown to be a factor of students' beliefs (Simsek, 2011). As stated previously, students who qualified for full-price lunch were more likely to have access to home computers and the Internet and in turn have higher self-efficacy levels.

Previous research has confirmed access to computers and experiences has a positive effect on computer self-efficacy (Hasan, 2003). This was also seen in this study as access limitations and cognitive limitations were found to have significant relationships. This could be

because most of the study participants had access to home computers and wireless Internet and used computers for at least an average of 1-10 hours per week for schoolwork and leisure activities.

Cognitive limitations can have a direct effect on the user's attitude and behaviors toward ICT and how they used it. Results showed this was the case by revealing a slight, positive correlation between behavioral and cognitive limitations. This relationship was found to be significant. Student perceptions of the course work, motivation to complete tasks, and overall interest in active tasks using technology in virtual environments can create behavioral limitations (Finnegan et al., 2008). In the case of this study, students' behavior in their virtual course seems to not be an issue.

Access and cognitive limitations had a significant relationship to home computer access, home wireless access, and home computer use for schoolwork. Results for home computer use for leisure and cognitive limitations had insignificant relationships. This could be because most study participants had access to home computers and wireless Internet and use computers for on average 1-10 hours per week for schoolwork and leisure activities. Previous research concluded that students tested with high computer self-efficacy used the Internet mostly for educational purposes such as doing research, downloading electronic resources, and e-mail communications (Sam et al., 2005).

Digital effectiveness was measured by the Information System (IS) Success Model. The IS Success Model evaluates students' comprehensive satisfaction and success in their virtual learning environments. The IS Success Model reviews six categories to determine effectiveness and success. Data analysis results found all categories of the IS Success model had positive relationships with one another and were found to be a predictor of Performance Impact as a

student outcome. When DeLone and McLean (1992) updated the IS Success Model, they proposed that system quality and information quality affect actual use and user satisfaction. This study found similar findings. System Quality and Information Quality were found to have a high, positive correlation to User Satisfaction. However, these categories did not have strong correlations to Actual Use. This may be because responses to the Actual Use questions varied. Most students' responses to Actual Use questions were split in the frequency of log-in between several times a day and once a day. Also, students reported spending an average of 2 to 4 hours per week in their virtual learning courses.

Data analysis tested demographic variables to the IS Success Model. There is not much literature on testing demographics to the IS Success Model. Results found ethnicity to be the only demographic to have a significant relationship to the IS Success Model. Service Quality, the quality of support received by system personnel, and Information Quality, the relevance of the content, were found to be strong predictors of this relationship. Black and Asian students reported lower measures of Service Quality. This may be because Asian students had low survey participation numbers. Also, Black students had varied experience with Service Quality in their virtual environments which could have depended on where they lived and where they went to school. As for Information Quality, Asian students had lower totals for Information Quality while Hispanic students had the highest. This means that Hispanic students had positive experiences with the virtual system content and felt like it was useful.

Access limitations were found to have significant connections to five out of the six categories of the IS Success Model. Findings showed significant relationships to System Quality, Information Quality, User Satisfaction, Actual Use, and Performance Impact. Service Quality was not found to have a significant relationship to access limitations. Previous research showed

that in some cases those that have physical access are usually more engaged (Harrison, 2005). That was also the case in this study as results showed students with access to home computers and wireless Internet and who used it regularly had favorable characteristics and perceptions of their virtual learning system.

Results showed student participants had positive responses to the way they behaved in their virtual learning courses. Those responses gave way to the positive correlations between behavioral limitations and System Quality, Information Quality, Service Quality, and User Satisfaction. Students, overall, were satisfied with their virtual environment and felt the virtual learning system was easy to use, the content was useful, and the service they received from the Technical Support staff was favorable. However, there were negative correlations between Actual Use and Performance Impact. This is not surprising because if students used the system less, then their performance in the course would also decrease. Also, negative behavior would lead to negative performance in their virtual learning environment. A perfect, positive relationship was found between behavioral limitations and Service Quality, which represents the support users received from support personnel. As service quality increases, so will the behaviors of students in their virtual courses. This could mean that students that have consistent quality support from virtual learning stakeholders will continue to see a positive increase in behaviors that will have a positive impact on their virtual course experiences and outcomes.

Previous research found those with high levels of self-efficacy in remote computer situations were more productive and satisfied, and better able to cope when working remotely (Staples et al., 1998). The findings of this study found that this is indeed also the case. Data analysis found positive correlations and significant relationships between cognitive limitations and all six categories of the IS Success Model. Low to weaker correlations were found between

cognitive limitations and Service Quality and Actual Use. This may be because Service Quality support does not impact students' beliefs as much. Also, students' actual use was split. Student frequency log-in and engagement was either multiple times a day or once a day, which was inconsistent.

Challenges and Limitations

There are several challenges and limitations associated with conducting this study. One challenge was finding and gaining access to survey participants. With the pandemic beginning in the spring of 2020, the United States saw a major shutdown. Schools in Alabama ceased providing in-person instruction in March of 2020 and moved to distance learning to complete the school year. Closures continued throughout the summer months when this study was set to begin. Even though schools began to reopen in the Fall of 2020, schools implemented varied modes of instruction options for students.

With the heightened demand for virtual learning options, Alabama purchased additional virtual learning programs that gave school systems more options than the free, supplemental program that has always been available. With these options, the program saw a decrease in enrollment. In turn, the pool of eligible survey participants was smaller. With students not having the normal procedures at schools, students were not interacting with the program as they would normally and there several difficulties reaching potential survey participants. This challenge caused time constraints to become a limitation on the study.

Based on the disparate representation in participants, student demographics were unbalanced and were not representative of the state's population. Students in rural, lower-income, and urban areas were not represented in this study as initially hoped. If data collection

were able to be extended, it could have been possible to see a disbursed distribution within all school community categories.

Another challenge in this study was survey participants not completing the survey. Out of the 331 participants, 175 respondents provided a complete dataset. This could be due to the length of the survey, which contained multiple sections and questions. Consistent with behavioral limitations, students may have gotten overwhelmed by the length of the survey or procrastinated, which led to not completing this task in a virtual environment. Changing the research design could also help with getting accurate responses from students. Student survey participants gave self-reported responses. Self-reporting could be biased, where students are not being completely honest in their responses. Self-report bias is the difference between the self-reported and true values of the same measure (Salters-Pedneault, 2020). Students may have given the more socially acceptable answer rather than being completely honest. Students also may not have assessed themselves truthfully. Depending on the day or how students were feeling when completing the survey, responses may also not have been accurate.

Last, to be approved for this study, there were some student data the researcher could not have access to. An accurate record of all students who were enrolled in the virtual learning environment and official student outcomes such as grades would paint a more accurate student picture to be able to see if students are digitally effective in their virtual courses.

Implications

This research contributes to the literature on digital limitations and digital effectiveness in virtual learning. This study can further the awareness of how the digital divide continues to evolve and how individual limitations or capabilities can make or break students' motivations and perceptions of virtual learning. Virtual students' access to Information Communication

Technology at home and school have an impact on how students interact and perform in their virtual courses where ICT and the Internet are the primary tools needed to be successful. Recognizing the need for these technology tools, having the ability to use them, and having positive outcomes and experiences in their virtual learning courses is strongly related to the success of a K-12 virtual program.

Virtual Learning Program and Local School System Administrators/Professionals

Data from this survey can provide virtual learning programs and local school systems with various checkpoints to assess students' needs and ways to ensure students are successful and have positive virtual experiences. The results of this study showed relationships between students' access, how they behaved in courses, and the belief in their capabilities. Therefore, the first step should be to ensure students who are working in virtual courses have what they need to participate in this mode of learning. On one hand, this study and previous research confirmed that access to computers and the Internet have increased over time. However, there still needs to be a discussion on the technology available for students taking virtual learning courses. Students in rural and low-income areas are still faced with inequalities in access to updated technology and stable Internet connection.

The goal for Alabama education is that each student graduates from high school with the knowledge and skills to succeed in post-secondary education or the workforce. The virtual learning options that are mandated by the state should be at the forefront of college and career readiness. Students need digital skills to be able to be competitive once they have completed their postsecondary studies. K-12 virtual programs and school administrators and cannot take for granted that students who have access to technology know how to use it effectively. The most basic technology skills training should be taught and used in every aspect of academic settings.

Virtual learning gives students those skills by using them. Students need the knowledge and confidence to use technology at the highest level. The connection access has to computer self-efficacy that was shown in this study is not surprising. The more students work on computers for an educational purpose, the more comfortable they will feel in their capabilities. Therefore, school systems should create opportunities for students to work with computers as often as possible. For example, school systems and virtual programs that offer one-to-one initiatives that give students a computer or device to work on throughout their educational matriculation are a great way to ensure access to equipment. One-to-one initiatives create equitable access for all students. These programs give students not only consistent access to the computers but can increase student confidence, motivation, and interest in digital tasks.

Last, measuring student effectiveness in virtual courses is key for program administrators and school systems who use virtual learning as a key component of their curriculum and instruction. To keep the pulse of students' behaviors and perceptions, it is important to do consistent checks on how students feel about the courses they are asked to participate in. Virtual learning stakeholders can use IS Success Model categories to ensure digital effectiveness in their courses. Using the IS Success Model, this study presented evidence that students who have high levels of behaviors in their virtual learning courses also have high levels of Service Quality, which is positive experiences with the virtual learning support staff. Examining these categories as benchmarks to assess content relevance ensures the system continues to be easy to use, and if the students are satisfied with their experience. Those responses can help programs adjust as needed.

Federal, Local, and State Government

The state of Alabama currently ranks 38th in the US in the field of state broadband access. Even though we see connectivity in larger populated areas, we still see the gaps of availability and affordability for citizens in rural and lower-income areas. The national average Internet speed is 99.3 Mbps. About 88.6% of Alabamians have access to wired broadband 25 Mbps or faster. Still, this leaves 475,000 people in Alabama without access to a connection capable of the same speeds. For families to qualify for "low-priced," Internet plans must cost $60 or less per month. Affordability data show that 44.4% of Alabamians have access to these plans. However, Alabama lags behind the national average of 51.5% of Americans who have access to a low-priced plan.

With these figures, federal, local, and state government officials should push for a remedy for the connectivity and affordability issues some families face. The Internet is now seen as a necessity. Grant funding has been allocated for broadband infrastructure. Mobile hotspots have been seen as another option to get rural broadband to rural areas. However, if you have faulty cell phone coverage, those hotspots will not work.

The expansion of affordable Internet is necessary especially as more rural students and school systems use Alabama's supplemental virtual program where the computers and the Internet are the major pieces of equipment needed. Therefore, funds should be allocated, and plans should be implemented, to put stronger communication technology in these areas that are affected the most.

Recommendations for Future Research

The findings of this study provide several opportunities for future research. The results of this study emphasize the impact students' access, use, and attitudes have on student success in

virtual learning environments. Due to the pandemic, The Alabama State Department of Education received money from Congress reserved to support increases in technological capacity and access to support remote learning. The strategies ALSDE intends to use to serve disadvantaged populations includes allowing school systems to use the funds to support the purchase of computers and hotspots for their students (Johnson, 2021).

Due to this statute, household home computer and wireless Internet ownership most likely increased during the data collection period. Even with this increase in access to ICT, what was not taken into consideration was student access to cellular devices and tablets. This study would have been enriched by asking how students use their cell phones and/or tablets to interact with their virtual learning courses. For example, students who answered no to having home computers and wireless Internet access could be using their smartphones and tablets instead and making use of personal hotspots via cell phone coverage to access the Internet.

The second recommendation would be to not use lunch costs as a demographic variable. School systems in the state have various programs and grants that make free lunch available for all their students regardless of income. Also, because of the pandemic, the USDA rolled out a universal free lunch for students to aid families experiencing hardships. Students were able to get meals regardless of income eligibility. This program was extended into 2021. With most of the students in this survey were receiving free lunch, this may have skewed the data. To gather a more accurate depiction of socioeconomic status, parent income or parent education could be a better indicator (Sirin, 2005).

Working with students in a setting where they will feel heard will always count for a more accurate student account. As time and the pandemic were counted as a challenge for this study, another recommendation is to complete a pre/posttest to render students' digital

limitations and see if there is any growth over time more accurately. A mixed-methods study may be appropriate to be able to gather more information on digital limitations and digital effectiveness while using student grades as an official learning outcome.

Last, for this population, not testing all six IS Success measurements would be a better fit. It could be better to focus on one to three dimensions that are better suited for the environment of success that is being tested. In this study, Actual Use questions were like another section of the survey, therefore creating redundancy. Some of the dimensions may no longer be relevant or may need to be measured differently depending on the system being tested.

Summary of Study

The purpose of this study was to examine how digital limitations (access, behavioral, and cognitive) impact the digital effectiveness of secondary level students enrolled in a virtual learning environment. Furthermore, the study sought to determine if demographics, how access to Internet and computer technology, ICT use, behavioral limitations of personal attitudes and motivations, and cognitive limitations of personal experiences and capabilities were related to the digital effectiveness of their virtual learning experience. Analysis of the demographic data indicated gender was related to access limitation of home computer use, ethnicity was related to behavior, and school lunch costs were related to cognitive limitations. Because of the increase of home computer and wireless Internet access, and how gender affects the frequency of how students used home computers, relationships between access limitations and cognitive limitations had a significant relationship. Although socioeconomic factors such as school lunch costs were found to have relationships to access limitations, most students reported having access to home computers and wireless Internet and used them for both schoolwork and leisure between 1-10 hours per week.

Students of different ethnicities were found to behave differently in their virtual learning courses. School lunch costs were the only demographic variable found to have a relationship to cognitive limitations. Behavioral limitations results showed that although some students found the content difficult, most students still somewhat agreed to feel confident and excited about the content. Procrastination and not having clarity for some graded assignments had effects on behavioral limitations. Overall, access limitations were found to have no effects on behavioral limitations. Student's behavioral limitations had a positive, slight correlation to cognitive limitations and were found to be a significant relationship. Participants overall had high computer self-efficacy as measured by cognitive limitations questions. On average, students felt confident with basic technology skills such as finding information using the internet, using the learning management system, and downloading and uploading files.

As digital effectiveness measures an individual's access and ability to use ICT purposefully, gender and lunch costs were found to have relationships with System Quality, which is the ease of use. System Quality had high correlations to Information Quality, User Satisfaction, and Performance Impact. Research findings revealed access limitations had significant relationships to how students viewed ease of use, viewed information and quality of relevance of the information provided in the system, level of satisfaction with the system, and the impact the virtual learning system had on overall academic performance. Behavioral limitations revealed slight, positive relationships to System Quality and Information Quality. Information Quality, the quality of support offered through the virtual learning environment, was perfectly correlated to behavioral limitations. Perceived information quality was significantly related to perceived usefulness performance impact. Findings showed students' overall computer efficacy

had strong to moderate correlations to IS Success Model categories that specifically deal with ease of use, flexibility, content understandability, and satisfaction.

The findings of this study can be used to continue assisting with the implementation and justification of the need for Information and Communication Technology at home and at school. With the increase of virtual learning becoming a more attainable option, policymakers can now have a point of reference to see how successful students can be when they have the necessary tools and knowledge to use them. School decision-makers may want to explore more initiatives to assist with getting computers in homes earlier so that students know how to use them and behave in their courses. Policy and decision-makers can use this research to measure the digital effectiveness of students in virtual learning platforms that are used. Also, when deciding to incorporate virtual learning into an educational setting, decision-makers can use these findings to see what works to ensure a successful student outcome.

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APPENDIX A

MODIFIED MEASUREMENT OF CONSTRUCT SURVEY

(ADMINISTERED TO ALL PARTICIPANTS USING QUALTRICS)

Construct	*Survey Questions*	*Source*
Demographics	1. Please indicate your sex: Male Female 2. *Please indicate your ethnicity: American Indian / Alaskan Native Asian Black Hispanic Multi-Race - Two or More Races Native Hawaiian / Pacific Islander White 3. *How do you pay for lunch? Free Reduced Price Full Price 4. *School System _____ 5. What grade was you in when you took your first virtual class? _____	Wei et al., (2011)
Access Limitation	1. Do you have a computer at home? Yes/No 2. Do you have wireless Internet access at home? Yes/No 3. *On average, I spend (choose one: 0, 1-10, 12 or more) hours in a week using the computer at home to do my schoolwork. ____0_____1-10_____12 or more 4. *On average, I spend (choose one: 0, 1-10, 12 or more) hours in a week using the computer at home for leisure activities (e.g., emailing friends, chatting online, and playing computer games, etc.)	Wei et al., (2011)

	___0_____1-10 ____12 or more 5. *How many computers are in the computer lab where you take your ACCESS course? (choose one: 0, 1-10, 11 or more) ___0_____1-10_____11 or more 6. *Are there enough computers in your classroom or lab for all of your classmates to use? Yes___No 7. *On average, I spend (choose one: 0, 1-4, 5 or more) class periods a day using computers to do work for my face-to-face classes. ___0_____1-4 ____5 or more	
Behavioral Limitations	Five-point Likert scale from"1-totally disagree" to"5-totally agree" for each 1. I do not understand when I go through virtual presentations. 2. I cannot focus on virtual presentations. 3. I prefer to do other things than study learning materials or resources. 4. I postpone starting things I don't like or want to do. 5. I keep postponing my study tasks designated in a course. 6. I do not know what to write in response to the discussion topics posted on discussion forums. 7. I do poorly in tests and examinations. 8. I feel confident when taking tests and examinations. 9. I find time to study the learning materials and/or resources in a course. 10. I am excited about the content that I am learning.	Schommer-Atkins & Easter, (2018)

Cognitive Limitations	Five-point Likert scale from“1-totally disagree” to“5-totally agree” for each Computer Self Efficacy (SE) 1. I have the needed skills to use the learning management system. 2. I am motivated to use the learning management system. 3. I feel confident finding information by using a search engine (e.g. Google) 4. I feel confident in the online learning sending and receiving e-mail messages 5. I feel confident in the online learning downloading and uploading files 6. I am confident about how to use the tools of the new system. 7. I am able to use the computer and its technologies.	Aldohlay et al., (2018)
IS Success Model	Five-point Likert scale from“1-totally disagree” to“5-totally agree” for each System Quality 1. I find virtual learning to be easy to use 2. I find virtual learning to be flexible to interact with 3. My interaction with virtual learning is clear & understandable Information Quality 1. Virtual learning provides up-to-date knowledge 2. Virtual learning provides accurate knowledge 3. Virtual learning provides relevant knowledge 4. Virtual learning provides comprehensive knowledge 5. Virtual learning provides organized knowledge	Aldohlay et al., (2018)

Service Quality

1. I could use the virtual learning services at anytime, anywhere I want
2. Virtual learning offers multimedia (audio, video, and text) types of course content
3. Virtual learning enables interactive communication

User Satisfaction

1. The virtual learning was what I expected.
2. Overall, I am satisfied with the virtual class

Actual usage

1. On average, how frequently do you log into your virtual class(es)?

□ Certainly not
□ Less than once a month
□ Once a month □
A few times a month
□ A few times a week
□ About once a
day
□ Several times a day

2. On average, how much time do you spend per week working in your virtual class(es)?

□ Almost never
□ less than 2 hours
□ 2–4 hours
□ 4–6 hours
□ 6–8 hours
□ More than 8 hours

Performance impact (PI)

1. Virtual learning helps me to accomplish my tasks more quickly
2. Virtual learning makes it easier to complete my tasks
3. Virtual learning improves my learning performance
4. Virtual learning enhances my academic effectiveness
5. Virtual learning helps reviews and eliminate errors in my work tasks

6. Virtual learning helps me to realize my future target
7. Virtual learning helps me acquire new knowledge
8. Virtual learning helps me acquire new skills
9. Virtual learning helps me to come up with innovative ideas

APPENDIX B

LETTER OF PERMISSION

STATE OF ALABAMA
DEPARTMENT OF EDUCATION

Eric G. Mackey, Ed.D.
State Superintendent of Education

May 5, 2020

Florence Williams
University Hall
275 Kilgore Lane
Box 870388
Tuscaloosa, AL 35401

Dear Ms. Williams,

You have permission to use the ACCESS data you requested as approved by the Alabama State Department of Education Legal Section. As discussed with our legal department, you agree that the ALSDE will not provide students' email addresses to you and will not approve the use of a raffle to encourage student participation. If there are any questions, please contact me.

Sincerely,

Lawrence W. Raines
Coordinator of Educational Technology

GORDON PERSONS BUILDING • P.O. BOX 302101 • MONTGOMERY, ALABAMA 36130-2101 • TELEPHONE (334) 694-4900 • FAX (334) 694-4990 • WEB SITE www.alsde.edu

APPENDIX C

SAMPLE RECRUITMENT EMAIL

Sample Recruitment Email

Greetings,

My name is Florence Williams, and I am a Doctoral student from the College of Education at The University of Alabama and an ACCESS Virtual Learning Program Manager. I am writing to request participation in a research study on how access to Internet and computer technology, personal attitudes and motivations, and personal experiences and capabilities affect the digital effectiveness in virtual learning experiences. The title is *Exploring the Impact of Digital Limitations on Students in Secondary Virtual Environments.* Eligible survey participants are past or current virtual students who are 18 years or older.

The survey will take no more than 1 hour. Please click the link below to go to the survey in Qualtrics (or copy and paste the link into your Internet browser).

Survey link:
Participation in the survey is completely voluntary and all of your responses will be kept confidential. Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate or have any questions about the study, please email or contact me at fowilliams@ua.edu or 334-505-0695.

Thank you very much.

Sincerely,

Florence O. Williams

APPENDIX D

ONLINE INFORMED CONSENT

Voluntary participation: Your participation in the study is completely voluntary.

Right to withdraw from the study: You have the right to withdraw from the study at any time without penalty.

How to withdraw from the study: You may withdraw from the survey by exiting the survey without submitting. If you want to withdraw from the study, there is no penalty for withdrawing.

Compensation/Reimbursement: You will receive no payment for participating in the study.

If you have questions about the study or need to report a study related issue please contact, contact:
Name of Principal Investigator: Florence Williams
Title: PhD Student
Department Name: College of Education-Education Leadership/Policy/Technology Study
Telephone: 334-505-0695
Email address: fowilliams@ua.edu

Faculty Advisor's Name: (Please include this information for student or staff research projects)
Department Name: Dr. Andrea Denham
Telephone: 205-348-1731
Email address: adenham@ua.edu

If you have questions about your rights as a participant in a research study, would like to make suggestions or file complaints and concerns about the research study, please contact:
Ms. Tanta Myles, the University of Alabama Research Compliance Officer at (205)-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make suggestions, or file complaints and concerns through the IRB Outreach Website at http://ovpred.ua.edu/research-compliance/prco/. You may email the Office for Research Compliance at rscompliance@research.ua.edu.

Agreement:

By clicking "I agree" below you are indicating that you are at least 18 years old, have read this consent form and agree to participate in this study.
☐ I agree to participate in the research study described above.

☐ I do not agree to participate in the research study described above.

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 12-12-20
EXPIRATION DATE: 12-11-21

APPENDIX E

IRB APPROVAL LETTERS

THE UNIVERSITY OF ALABAMA | Office of the Vice President for Research & Economic Development
Office for Research Compliance

June 12, 2020

Florence Williams
College of Education
The University of Alabama
Box 870302

Re: IRB # 20-02-3330: "Exploring the Impact of Digital Limitations on Digital Effectiveness in a Secondary Virtual Learning Environment"

Dear Ms. Williams,

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your application has been given exempt approval according to 45 CFR part 46. Approval has been given under exempt review category 2 as outlined below:

(2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects

The approval for your application will lapse on June 11, 2021. If your research will continue beyond this date, please submit the annual report to the IRB as required by University policy before the lapse. Please note, any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

Please use reproductions of the IRB approved informed consent form to obtain consent from your participants.

Sincerely,

[redacted]

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer

Jessup Building | Box 870127 | Tuscaloosa, AL 35487-0127
205-348-8461 | Fax 205-348-7189 | Toll Free 1-877-820-3066

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NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	June 15, 2020	
TO:	Williams, Florence, College of Education	
	Denham, Andre, Ed Leadership/Policy/Tech Studies, Laanan, Frankie, Educational Leadership, Policy, and Technology Studies	
FROM:	Graham, Jeanelle, MPH,Research Compliance Specialist, NM Expedited	
PROTOCOL TITLE:	Exploring the Impact of Digital Limitations on Digital Effectiveness in a Secondary Virtual Learning Environment	
FUNDING SOURCE:	NONE	
PROTOCOL NUMBER:	20-02-3330	
APPROVAL PERIOD:	Approval Date: June 12, 2020	Expiration Date: June 11, 2021

The Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Exploring the Impact of Digital Limitations on Digital Effectiveness in a Secondary Virtual Learning Environment. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under University of Alabama's Federal Wide Assurance 00004939 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under Committee's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Graham, Jeanelle

Graham, Jeanelle

Approval Period:	June 12, 2020 through June 11, 2021
Review Type:	FULLBOARD
IRB Number:	03