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The Effects of 1:1 Technology on African American Students' Achievement in Algebra and English

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Abstract

Many educational leaders have questioned whether the increased availability of technology in classrooms helps to increase student achievement and narrow the persistent achievement gap between African American and White students in the United States. School leaders have made large investments to provide every student with an Internet-capable mobile device. These 1:1 initiatives have grown in popularity in the U.S., and specifically in Texas. The research on 1:1 technology programs, however, has been mixed and sometimes contradictory. The purpose of this study was to determine if a 1:1 technology program increased student achievement for African American students and if it helped to close the persistent achievement gap. The research design for this study was a quantitative research methodology that included a causal-comparative model. The study focused on 18 high schools in Texas. Nine schools had a 1:1 computing program where every student received a laptop. Nine schools did not have a 1:1 computing program. Independent *t* tests were run to determine statistical significance. Cohen's *d* tests were used to determine practical significance. The results of the study indicated 1:1 technology had a statistically significant negative impact on Algebra I scores. Mean scores were lower in English I, but not at a statistically significant level. Results suggested technology saturation within the classroom did not increase student academic success on standardized tests. These findings contributed important information for schools and districts striving to increase student performance on state-mandated standardized assessments.

Keywords: technology integration, 1:1 technology, achievement gap, standardized assessment

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Chapter 1: Introduction

On May 15, 1954, the Supreme Court unanimously ruled the segregation of schools based on race was unconstitutional. Desegregating those first schools exposed an achievement gap between African American and White students in the United States (Blackford & Khojasteh, 2013). Despite numerous efforts through the years to eliminate this gap between African American and White students, many African American students continue to struggle academically. Additional school interventions have been proposed to target the achievement gap today. For example, increasing technology in classrooms for all students is meant to close the achievement gap between student groups. Educators believe making technology available for all students will reduce the gap between White students and their underperforming African American counterparts.

The journey of technology in education is decades old and will continue for decades to come. As technology changed, so has its incorporation into education. As one of the first significant steps, “January 24, 1984, will be remembered in the technology world and elsewhere as the day Apple launched the Macintosh computer” (Green, 2015, p. 40). School leaders purchased these first computers that provided students access to word-processing programs. These programs changed how students wrote and edited papers, but this was just the beginning of changes to come. Even though the technology industry has become more consumer driven, it has always found its way into classrooms.

Since those first computers were introduced over 30 years ago, technology has continued to impact education. At the turn of the century, new technologies were being invented almost monthly, bringing new possibilities with them (Firmin & Genesi, 2013). Partly because of those advances, teachers now have learning-management systems (LMSs) such as Schoology, Moodle, and Blackboard at their disposal, allowing for instruction in the classroom and at home. In addition, programs such as Kahoot, Socrative, and Padlet allow for immediate in-class assessment of student learning providing teachers with faster and more efficient ways to check for understanding. Programs such as these alter the way teachers interact with students and provide opportunities for new learning models in and out of the classroom (Pechendina & Aeschliman, 2017). The evolution of technologies and their application in the classroom continues to affect the way teachers teach and students learn.

New technologies have led to expectations for continuous technology use in classrooms. States have embedded technology into current curriculum requirements. The Common Core, adopted by 42 of 50 states, included requirements for students to become technologically savvy (Chernoff, 2018). In Texas, Common Core was not adopted, but technology requirements were interwoven throughout many of the Texas Essential Knowledge and Skills (TEKS) for each subject. This legislated requirement for technology instruction coincides with the demands of business leaders who seek employees with 21st-century computer skills (Campbell, Jr. & Kresyman, 2015). Educational leaders have demanded that more technology should be woven into classrooms and they evaluate teachers on such elements. Furthermore, parents desire their children to be trained in the newest technology available so they can succeed in a competitive global world. The increase of technology use in classrooms has become an expectation by all.

Technology integration is such an important part of education that many schools, districts, and nations have incurred great cost to ensure every student has a computer, laptop, or tablet assigned to them. These one-to-one (1:1) initiatives have become popular not only in the United States, but around the world. For example, in Uruguay, every primary school student now receives a free laptop. In Portugal, the government has also rolled out a scheme for every student to have their own laptop. These countries chose to invest in 1:1 computing for all of their students, and many other countries are engaged in pilot projects on a smaller scale (Valiente, 2010). One might argue the push for 1:1 technology in the United States is an attempt to keep up with other countries that already have implementation policies and close an academic gap between the U.S. and other higher performing countries.

An increased level of technological interventions do not come without sacrifice. The cost of a device for every student is substantial. Increased access to technology includes not only the cost of providing an Internet-capable device to every student, but also the high cost of ensuring a reliable Internet connection. While there is much to be considered, it is clear that quick Internet services and quality products are key to maintaining a successful initiative, but speed and quality often come with a hefty price tag (Chernoff, 2018). In addition to the speed of the network, the security of the network must be robust because it is put at risk when devices are taken home by students and then brought back and connected to the school's service. The amount of bandwidth is also an important consideration because it needs to be sufficient for all students, taking into account usage at peak times throughout the day. The design of the building must also be considered to determine the actual physical location of wireless router points for maximum functionality. All of these considerations add to the enormous cost of a 1:1 program.

In addition to the considerable cost of a 1:1 program, educational leaders also must determine whether it will help student academic achievement. There has been an achievement gap between Black and White students in the United States since schools were established (Blackford & Khojasteh, 2013). Educational leaders continue to search for instructional tools and strategies they can provide to teachers and to students to close this gap for all learners. Poverty plagues many African American students who come to school with fewer educational resources. According to Bowman et al. (2018) "In 2015, some 38% of Black children lived below the poverty line, a percentage four times greater than that of White or Asian children" (p. 17). These students have fewer technological resources available to them when they head home to study than their more affluent counterparts. As teachers and students become more technologically dependent, the disadvantage from the lack of access to technology grows. Providing an Internet-capable device to every student could help with the academic achievement of students who struggle most.

Educational leaders seek evidence that 1:1 initiatives increase student achievement to close the gap between African American students and their White peers. This is in part because of the push from parents, community, and business leaders for 1:1 implementation. In previous research, Bebell and O'Dwyer (2010) noted a lack of studies on the effects of 1:1 technology on minority groups, such as African Americans, and on specific subjects, such as mathematics and language arts (Bebell & O'Dwyer, 2010). Additional research in these areas allows educational leaders to make more informed decisions on what type of technology to implement in their schools, in which subjects to implement it, and with which student groups. This evidence would allow educational and community leaders to be more confident in their decisions to increase technology use within schools or apply resources to other areas.

Statement of the Problem

An achievement gap between White and African American students remains in schools across the United States despite increased technology use in classrooms intended to raise student achievement. There is a clear trend toward costly 1:1 technology programs within education without evidence of its effect on student learning. These laptop initiatives are propelling educational change intent on providing benefits to improve academic achievement for all students (Richardson et al., 2013). Despite the trend, the achievement gap between African American and White students persists in Texas and in the United States (Barnes & Slate, 2014). Evidence of the effects 1:1 technology has on student learning is needed to help school districts make informed decisions on program implementation.

The specific problem examined in this study was whether 1:1 technology programs increased student academic achievement and thereby helped to close the achievement gap between African American and White students. Therefore, my problem of practice investigated the effects 1:1 technology initiatives had on Algebra I and English I standardized test scores for African American students in selected Texas high schools.

Purpose Statement

I designed this study to determine if African American students at schools with 1:1 technology programs performed higher academically than African American students who did not participate in a 1:1 initiative. I sought this evidence for school superintendents concerning the achievement levels of high school students using 1:1 technology programs and those who did not participate in such programs. I wanted to identify whether there was a significant statistical or practical difference in English I and Algebra I standardized test scores for ninth-grade African American public-school students who participated in a 1:1 technology initiative versus those who did not.

I collected and analyzed data from end-of-course (EOC) exams to determine if 1:1 initiatives impacted student achievement. I examined nine campuses with 1:1 technology programs and nine campuses without such technology, then used a quantitative method to determine if there was a significant statistical or practical difference in student performance on the Algebra I and English I EOC exams.

Research Questions

Q1: How does participation in a 1:1 technology program affect academic achievement in Algebra I among African American high school students?

Q2: How does participation in a 1:1 technology program affect academic achievement in English I among African American high school students?

Significance

Many educational leaders have continued to look for instructional practices, interventions, or resources to close the achievement gap for African American students. At the same time advancements in technology have changed instruction in the classroom and have become tools to extend learning outside of the normal school setting. First, educational leaders must determine if the use of 1:1 Internet-capable devices can increase student achievement for African American students. Then, superintendents and other educational leaders must justify, with impact data, the expense required to achieve technology saturation. This study contributes to existing research and helps educational leaders make informed decisions about technology purchases and implementation in their districts and schools.

Assumptions and Limitations

The study included three assumptions: (a) the Texas Essential Knowledge and Skills (TEKS) for Algebra I and English I were taught throughout the year, (b) students took the EOC exams seriously, and (c) students tried their best to pass the tests. The EOC exam assesses the students’ knowledge of the TEKS, therefore, I assumed teachers were teaching the TEKS so students could do well on the required exam. Students were required to pass the EOC exams for Algebra I and English I to receive credit for the respective class. If students did not pass the EOC exam, they did not meet graduation requirements in the state of Texas.

The limitations of this study included the type of technology assigned to the students and the level to which technology was integrated into lessons. Nine of the 18 high schools chosen for this study assigned every student a laptop to use both at school and home. Different forms of technology, such as tablets, may have affected the results of this study. In addition, the amount of professional development provided to teachers and the degree to which they integrated the technology into their classrooms created additional limitations. I also did not know how much the technology was used during instruction.

Definition of Key Terms

1:1. One to One (1:1) is an educational setting in which every student has access to a technology device (Bebell & O'Dwyer, 2010).

1:1 technology. Students have access to Internet-capable technology throughout the day (Sheninger, 2014). For the purpose of this study, 1:1 devices are defined as Internet-capable laptops provided to students by the school district they attend. Students are allowed to take these devices with them so they have access at school and home.

Achievement gap. This is the divide between the academic achievement of White students and Hispanic or African American students (Blackford & Khojasteh, 2013). This study will focus on the divide between White students and African American students only.

Campus comparison group. Each campus in Texas is grouped with other schools similar in population/demographics (Texas Education Agency, 2017–18).

End of course exams. EOCs are a series of exams required by the state of Texas for students to earn credit in selected high school courses. For the purposes of this study I used Algebra I and English I exams (Texas Education Agency, 2017–18).

Student achievement. This is the measure of student learning determined by performance on various assessments. For the purpose of this study, I used EOC exams to measure student achievement.

Technology integration. This is the extent to which technology is used within the classroom during instruction and the quality of the use toward student learning.

Summary

An achievement gap between African American and White students persists in in today's schools. Educational leaders continually search for ways to level the playing field and ensure every student has the tools needed to succeed. Technology is no exception as educators have explored ways to integrate technology into the classroom for decades. This journey has led many schools, districts, states, and countries to initiate 1:1 technology programs for their students. Chapter 1 presented an overview of the developing use of technology and increasingly popular 1:1 initiatives around the world. Educational leaders feel pressured by legislators, business, and community leaders to devote the resources needed to purchase technology for every student. Educational leaders need additional research on the effects of 1:1 technology on the academic achievement of all students to determine the optimal level of technology implementation within their own districts.

Chapter 2 provides a literature review on the existing research on technology use in education, including some previous studies of 1:1 implementation. Chapter 3 describes how I identified participants and comparable districts, explains my data collection methods, and presents the process I followed to evaluate the data. Chapter 4 includes the data analysis and the presentation of findings. The fifth and final chapter presents the conclusions I drew from the study and areas for possible further research.

Chapter 2: Literature Review

An achievement gap between White and African American students exists in schools across the United States. Many educational leaders question whether increasing the technology available in classrooms and homes increases student achievement and narrows the gap. As technology advancements change the world and cause it to feel smaller, they affect every aspect of our lives, including classroom instruction. These advancements have helped to transform the world into a global economy where anyone with a smartphone can instantly connect to others anywhere at any time. With the swipe of a finger, one can bank, shop, and even search for a job online (Huffman, 2018). Additionally, people stay connected to old friends and find new acquaintances through social media applications that allow for instant communication. These same advancements have led current business leaders to seek graduates with greater technological skills to give their companies an advantage in a global market (Campbell, Jr. & Kresyman, 2015). The important role technology plays in the world, as well as students' familiarity with it, correlates to a demand by parents, community, and educational leaders for technology to also play a role in classroom instruction.

This chapter is a review of literature on the topics relevant to the current study. I explored the achievement gap from the time of school desegregation to the present day. I review a brief history of technology, current advancements, and technology integration in classrooms. The remaining sections address previous and current research on 1:1 technology implementation and systemic reviews of the effects of 1:1 computing in education. The chapter ends with a call for further research as demonstrated throughout the review of literature.

Achievement Gap

On May 15, 1954, the Supreme Court unanimously ruled the segregation of schools based on race was unconstitutional. From the time those first schools desegregated, an achievement gap between Black and White students in the United States became evident (Blackford & Khojasteh, 2013). This achievement gap was ignored for over a decade by political and educational leaders until legislators passed the Civil Rights Act of 1964. This law, signed by President Lyndon B. Johnson in July 1964, required that a study be conducted to investigate educational opportunities based on race, color, religion, or national origin. The resulting report, James Coleman's 1966 study, *Equality of Educational Opportunity*, investigated the educational equity within schools after desegregation. Coleman's research design and the variables addressed in his study switched the indicators for measuring school quality (Bartz, 2016). Previous indicators for school quality included school expenditures, teachers, class size, size of the library, and the quality of classrooms, such as science labs. Coleman suggested student achievement, graduation rates, and impact on adult life should be used instead to determine the effectiveness of a school. In addition, the Coleman report presented significant differences between the achievement levels of African American and White students (Bartz, 2016). Although this evidence was shocking at the time, it has now become commonly acknowledged.

Many leaders have attempted to reduce the achievement gap between African American and White students. This gap has been the target of school intervention programs such as magnet schools, school vouchers, and charter or private schools. States have created accountability models aimed at improving academic achievement and government leaders have enacted sweeping national and state policies requiring schools to address the gap. Political and educational leaders have continued to search for ways to level the playing field for all students.

In 2001, the Bush administration introduced the No Child Left Behind (NCLB) Act which targeted the achievement gap and demanded improved test scores for all students (Blackford & Khojasteh, 2013). NCLB required states to implement assessments linked to state content and academic achievement standards for all public-school pupils in Grade 3 through Grade 8 in reading and mathematics by the end of the 2005-2006 school year. The law then required states to be accountable for the results of their state tests by demonstrating adequate yearly progress. This was the progress that states, school districts, and schools were expected to make so they could ensure every student reached proficiency in reading and mathematics by the 2013-2014 school year (Ametepee et al., 2014). This new indicator increased pressure to perform. The state measured a school's progress through the results on required state assessments. When states could not demonstrate they were meeting the required AYP, monetary consequences were imposed, creating an environment of high-stakes testing.

The NCLB program did not always produce the results legislatures had intended. NCLB gave states flexibility to create their own assessments and plans on how to meet the AYP requirements for improved scores. Although the federal government had good intentions with NCLB, this flexibility, paired with the expectations of AYP, led many states to make drastic changes in order to avoid the loss of funding. Many states reduced already low standards to increase passing rates. In addition, some states narrowed their curriculum focus to mathematics and reading only. Other schools adjusted their schedules to allow more time for tested subjects resulting in less emphasis on other subjects. This resulted in unintended consequences on learning for many students because "states manipulated the curriculum in several ways and as a result, students continue to fail to receive the education appropriate for the 21st century" (Ametepee et al., 2014). In addition, instructional time for nontested subjects was reduced to prepare students for the required tests. It is clear to both supporters and critics that NCLB did not reduce the achievement gap as it was intended to do.

President Barrack Obama also contributed to education reform with his Race to the Top initiative. This competitive grant program encouraged states to support innovation in education by awarding money to application winners. From the very beginning of the program, the president saw Race to the Top as a way to induce state-level policymaking aligned with his education objectives (Howell, 2015). The Race to the Top legislation consisted of three phases during which states could receive additional funding for meeting identified educational policies. The Obama administration selected which specific policies would be rewarded and how much reward each policy would receive. The initiative had a significant effect on the production of education policy in participating states across the United States.

Despite the aforementioned policies, the achievement gap persisted in many states, and Texas was no exception. In a study of college readiness in Texas, Barnes and Slate (2014) noted in 2009 that 62.7% of White students were considered college ready in math, whereas only 48.31% of Hispanics, and 38.41 % of African American students were prepared. Similarly, the same study showed college readiness rates in reading for high school graduates in 2009 were 61.89% for Whites, 47.86% for Hispanics, and only 44.48% for African American students. Additionally, the Texas Education Agency's (TEA's) website published statewide results each year confirming the achievement gap remained throughout Texas (Texas Education Agency [TEA], 2017-18). These results demonstrated the achievement gap still existed in Texas schools, much as the rest of the country.

The role of poverty as a contributor to the achievement gap cannot be ignored. The poverty rates for African American students far exceed the rates of non-Hispanic Whites. In 2010, over 27% of African American students were considered poor, while less than 10% of White students fell into this same category (Hunter, 2015). Poverty meant fewer educational resources, such as access to technology, for poorer African American students. Once again, this provided an advantage to wealthier White students who had access to such technology at home. The development of new technologies only served to escalate the impact of this advantage until all students had continuous access to Internet-capable technologies. Poverty has continued to be a disadvantage for many African Americans students.

The effect of poverty also has an impact on teachers who teach in these low-income schools. A survey of teachers who instruct American middle- and secondary-school students found significant differences in classroom technology use for lower-income students compared to their middle- and upper-income peers (Purcell et al., 2013). The survey revealed 70% of teachers working in the highest income areas say their school does a “good job” providing teachers with the resources and support they need to incorporate digital tools in the classroom, compared with 50% of teachers working in the lowest income areas. Additionally, technology usage in the classroom varies significantly. For example, 55% of higher-income students use e-readers while only 41% of low-income students use them; 52% of high-income students use cell phones compared to 35% of low-income students; and finally, 56% of teachers of students from higher-income households say they or their students use tablet computers in the learning process, compared with 37% of teachers of the lowest income students (Purcell et al., 2013). These results demonstrate the role poverty plays in contributing to the achievement gap—fewer resources are making it into lower-income classrooms.

As educators continue to look for ways to close the achievement gap, many schools and districts have turned to technology to help improve academic achievement for all students by increasing engagement and student performance in the classroom. In this study, engagement was defined as the level of attention, commitment, and investment students have in the learning taking place (Schlechty, 2002; Trowler, 2010). In a 2017 study, Ferguson reported iPads significantly increased student engagement in the classroom. Ferguson suggested if technology increased engagement, then an increase in student academic achievement was possible. If so, the inclusion of such technologies would contribute to narrowing the achievement gap for all students, including African Americans.

State of Texas Assessment of Academic Readiness

Standardized testing has been a part of the Texas education system for decades. In 1979, the state legislature passed testing mandates that required every student in Grades 3, 5, and 9 to take the Texas Assessment of Basic Skills (TABS) test beginning with the 1980 school year. Since that time, the accountability system in Texas has grown as the test has changed. The State of Texas Assessments of Academic Readiness (STAAR) test is the fifth and most recent state-wide standardized test. The STAAR program was implemented in 2012 and includes annual assessments for Grade 3 through Grade 8, English I, English II, Algebra I, Biology, and U.S. History (TEA, 2017-18). Students in Grade 5 and Grade 8 must pass their grade-level required test to earn promotion to sixth or ninth grade, respectively. In addition, high school students must pass their Algebra I, English I, English II, Biology, and U.S. History exams to earn a high school diploma from a Texas public or charter school as required in TEC 39.025 (TEA, 2017-18). Students who do not pass mandated tests cannot graduate. Underperforming schools must undertake increased paperwork to document improvement plans. Ultimately, a school that was unsuccessful for five consecutive years could be closed by the education commissioner (Huffman, 2018). Because of the imposition of penalties on the student and the district for subpar performance, state tests are considered high-stakes exams (Polson, 2018).

This research focused on the Algebra I and English I EOC exams. The Algebra I exam consisted of five assessed reporting categories: (a) number and algebraic methods; (b) describing and graphing linear functions, equations and inequalities; (c) writing and solving linear functions, equations, and inequalities; (d) quadratic functions and equations; and (e) exponential functions and equations. Each category included six to 14 questions on the test. The test consisted of 49 multiple-choice and five gridded questions for a total of 54 questions (TEA, 2017-18). The English I exam consisted of six assessed reporting categories: (a) understanding/analysis across genres; (b) understanding/analysis of literary text; (c) understanding/analysis of informational text; (d) composition; (e) revision; and (f) editing. Each category included eight to 13 questions, with the exception of writing which consisted of one composition, for a total of 52 multiple choice questions (TEA, 2017-2018).

History of Technology

There is no arguing technology usage in homes and schools across America has continued to increase at a rapid pace. Whether it is from societal pressures, marketing techniques, or a shift in vision, educational technology has become more prevalent in schools than ever before (Sheninger, 2014). Since the definition of technology was broad, for the purposes of this study, I considered technology as educational technology. Educational technology can be defined as any technology-based resource used to facilitate learning and improve performance by creating, using, and managing appropriate technological processes and resources (Januszewski & Molenda, 2008). The types of technologies introduced into the classroom have continued to expand. From the first computers to the tablets, laptops, and virtual reality viewers available today, technology continues to have an impact on student learning. The way technology has evolved and entered the classroom has made an impact on instruction. The many advancements in technology continue to change how educators try to engage learners on a daily basis.

Educational uses of computers began in the early 1970s with the emergence of drill, practice, and tutorial software. By the late 1970s and early 1980s, educators were looking for ways to use computers to reduce the teacher’s load of paperwork (Little & Suthor, 1987). Word processors and electronic grade books enabled teachers to save time. Some educators believed if the teacher's job were made easier; the result would be better instruction and improved student achievement. The 1980s led to lower-cost computer hardware, better trained instructors, and new software such as spreadsheet, database, and word processing programs. Computers like the Apple IIGS allowed for use of desktop publishing for students and teachers (Monahan, 1989). These conditions allowed more computers, albeit still few, to enter classrooms for students' use and not just for teachers' use. However, with the number of devices per classroom still extremely limited, computer use for instructional purposes remained limited.

By the 1990s, the widespread use of computers in the business world caused educators to examine how they could bring technology into the classroom and prepare students for success after school (Okpala & Okpala, 1997). Computer software was still being used for word processing and basic mathematical calculations; however, new programs provided enrichment and helped struggling students improve their skills. Although teachers could see the obvious benefits of computer usage, they also cited considerable cost in terms of time to find appropriate software, learn new applications, and arrange for student access to the limited numbers of computers available on campus. This led many district administrators to create campus computer coordinator positions. According to Strudler (2010) "They believed the school-level coordinators would work themselves out of a job" (p. 223). However, quite the opposite happened. The need for these campus technologists increased as educators expanded the ways they used technology. The technologist position began to have two key roles: technology maintenance and curriculum integration. Computer coordinators provided professional development on new technologies and how to use them. The goal was for teachers to feel more confident integrating technology into the classroom.

During the 1990s, homes connected to the Internet through simple phone lines via Internet modems. Internet providers such as America Online and CompuServe introduced families to a new world of endless information (Kraut, 1996). At the same time, this technology was introduced to colleges and universities, providing new ways to access information. The availability and use of applications on the Internet grew at an astonishing rate. Students possessed new ways to research, study, and communicate with professors. School libraries began to have designated areas for computer research and web browsing.

Throughout the next decade, Internet availability expanded, as did the speed. Throughout the late 1990s and into the 21st century, broadband and cable Internet were introduced to consumers and increased speeds by up to 250 times what dial-up could offer (Bentolucci, 2006). Online access became a necessity for home and work. As the speed of the Internet increased, so did the number of available wireless networks allowing consumers to use mobile technology in more places. Businesses began to advertise free wireless networks in an attempt to entice customers into their stores. The expansion of wireless networks made the portability of Internet-capable devices even more important. Therefore, devices became smaller in size, more portable, with increased data storage and processing capability (Cridland, 2008). The World Wide Web had transformed how the world received its information. As the web continued to grow, multiple tools were created or expanded which allowed for new ways of communicating.

How Technology Affects Learning

Over the last three decades, many of the aforementioned technologies have become more affordable and portable. This has made it possible for educational leaders to provide technology access to students and teachers. As of 2017, between 57% and 79% of students used laptops during class on a regular basis (Carter et al., 2017). As laptops, tablets, and other instructional technologies are more easily introduced into classrooms around the world, multiple studies have continued to investigate the overall positive or negative effects, the degree of impact on various student populations, the optimal availability, and usage by students. Teachers continued to search for the best applications to engage and excite their students to learn and achieve more.

Elliott-Dorans (2018) conducted a study that lasted two semesters involving an introductory American Politics course at a large, public, four-year university in the United States. The results of the study indicated that not allowing students to use laptops during class hindered their academic performance. Elliott-Dorans concluded a laptop ban policy did more to reduce student performance than increase it. Although the laptops could serve as a distraction, they typically led to higher student engagement. Students reported greater motivation to learn and more interaction with class materials.

Web 2.0 Technology Tools

The introduction in the mid-2000s of Web 2.0 as an innovative web technology created a more interactive and personalized World Wide Web (Seo & Lee, 2016). A Web 2.0 website allows users to interact and collaborate with each other through social media dialogue as creators of user-generated content in a virtual community. Web 2.0 offers powerful digital and social media technologies to promote interaction between users in various digital formats. This contrasted with the first generation of Web 1.0-era websites where people were limited to viewing content in a passive manner. Web 2.0 applications have been used increasingly in different contexts, allowing users to execute different actions for effective communication and sharing (Faci et al., 2017). Social media, blogs, online gaming, and video streaming have all been improved or are a result of Web 2.0, which continues to increase in size and availability. This has allowed people to stay connected and instantly communicate events and opinions, regardless of geographical location. Several researchers have emphasized that the development and growth of new Web 2.0 technologies has offered new benefits for educators at all levels of education (Cakir et al., 2015).

People have always desired to share stories with one another. In fact, some stories have been passed down from one generation to another, allowing individuals to learn from other's mistakes and successes. The Internet became another medium for this type of storytelling through blogs. Blogs have given consumers the ability to share ideas, opinions, and daily life experiences with many people at once. The personal blog provided a one-to-many channel similar to, but not as intrusive as, email (Wolf, 2014, p. 9). Two of the most popular blogging host websites included WordPress and Blogger, which offered free blogs with easy graphical interfaces for constructing posts and changing layouts (Gupta et al., 2013). Blogging style websites have been created to allow students to share learnings with instructors and other students through photos and text.

In addition to sharing their daily events through text and pictures, students can share through video. Blogging gives users the freedom to add text content to the web; vlogging extends this capability by allowing video content. Vlogging is a form of blogging using video instead of text. One of the most popular websites for vloggers is YouTube. Every month more than 6.5 million Internet users visit YouTube looking for videos about cooking, simple maintenance, news, product reviews, and more (Condruz, 2017). Many people turn to YouTube and other vlogging sites to search for ways to improve their busy lives. This type of learning is also becoming more prevalent in schools and universities. Although vlogging initially served as a form of entertainment, it has made its way into classrooms because this form of media has attracted student's attention. Many young people are not only media consumers but creators, with over 59% saying they have vlogged themselves (Condruz, 2017).

Blogging and vlogging each bring new possibilities for interactive learning into the classroom. Condruz (2017) listed 24 reasons and ways blogs should be used in the classroom. Blogging and vlogging (a) improve reading, written and overall communication skills, (b) direct more learning by doing and less by planning and executing, (c) give shy students a chance to participate in discussions, (d) allow teachers to provide tasks online, allowing access at home, (e) encourage opportunities for students to review and comment on each other's work, and (f) provide another means for class projects as students can post video, audio, text, or image material (Condruz, 2017).

In addition to blogging, social media sites continued to expand in the beginning of the 21st century, allowing individuals to share their daily activities instantly. The use of social media and a learning management system (LMS) within the classroom is relatively new. However, throughout the last decade, many LMS and social media applications have been introduced to the learning environment in an attempt to increase student engagement. An effective LMS consists of multiple resources for students and teachers creating complex systems. The systems can share features such as online assignment distribution and collection, quizzes, web-based grade books, and social tools (Robinson, 2017). Schoology is an LMS that allows teachers to create engaging lessons in less time thanks to many of these features. Its discussion forum allows students to collaborate, provides a space for instructional videos, accommodates submission of student work, and facilitates timely feedback from teachers (Remis, 2015).

LMSs have led many teachers to "flip" their classrooms, changing the way and the time they deliver instruction. A flipped classroom moves away from traditional teaching methods by delivering lecture instruction outside class, while devoting class time to collaboration and problem solving (Altemueller & Lindquist, 2017). It allows the teacher to facilitate and coach while students complete hands-on learning inside the classroom. It brings the application of learning from homework to class work, and gives students the resource of a teacher while applying new concepts. This makes it easier for the teacher to provide differentiation within the classroom. Through the assignment of tiered activities based on each student's individual needs, teachers can meet students where they are. Thus, they can challenge every student to improve academically regardless of their current level.

Social media applications and LMSs can be used outside of class to extend the classroom and provide student interaction on topics of learning. Twitter is one such social networking site which allows users to create posts up to 140 characters in length. Twitter is especially useful for in-the-moment conversations. Through the use of a hashtag (#), users are able to aggregate "tweets" according to topic. The most widely used social media site is Facebook. As of the first quarter of 2017, Facebook had 1.94 billion active users each month with 1.32 billion users signing in each day (Jin, 2018). This site allows individual users to create public profiles and communicate with friends through text, photos, and video. Another popular social media site is Pinterest. It is a "web-based social media platform that allows users to collect and post images extracted from the Internet to a virtual board for later viewing" (Amer & Amer, 2018, p. 133). This social media platform primarily uses photos to share everyday life interactions between users. Pinterest is the fifth most popular social network as of December 2016 (Amer & Amer, 2018).

Learning Management Systems and Social Media for the Classroom

LMSs and social media applications provide real-time communication, creating a highly interactive environment through which classmates can create, share, and exchange ideas (Rueda et al., 2017). Many educators have started to take advantage of the flexibility these systems provide. In a study conducted in 2017, Rueda et al. demonstrated social media plays an amplifying role to the effects traditional educational technologies have on student engagement. Students find social media applications to be user friendly, while educators like the exchange of ideas that can occur on them during noninstructional time. They also provide flexibility to nontraditional learners who desire to take classes during traditionally noninstructional times such as evenings and weekends.

The use of Web 2.0 software in education is not limited to academic discourse. Interactive software is also being used to help teachers ensure effective classroom management. The program Class Dojo is one of the programs that provides an interactive platform for teachers to give real-time feedback to both students and parents about student behavior. The program, operated with any mobile device or computer, provides students feedback on behavior expectations by awarding or deducting points for specific behaviors. Because feedback can be customized, it allows teachers to address individual student behavior and class-wide behaviors. In a study conducted in a fifth grade through eighth grade middle school, 64.6 % of students reported they felt their attention in class had increased since using the program (Cetin & Cetin, 2018).

In addition to social media applications, teachers use LMSs for conducting online assessments and quizzes, communicating with stakeholders, and posting assignments and grades for students. A recent study showed many teachers in the College of Technology at Purdue University welcomed the advantages the LMS Blackboard brings. Little-Wiles and Naimi (2018) examined full time professors' perceptions and attitudes toward online LMSs. The study included a 35-question survey focused on how faculty utilized the features of the Blackboard system. The results showed teachers were willing to utilize the features of an LMS to facilitate their classes. Blackboard is also making its way into secondary schools as teachers become more comfortable with an online format.

Technology in Mathematics

Technology has changed at a fast pace over the last three decades, including how teachers use it in the classroom. Technology in mathematics has traditionally been used with rote learning techniques that simply enhanced traditional learning. However, many educators are searching for ways technology can assist them in transitioning to the role of facilitator, where the students learn through problem solving (Bray & Tangney, 2017). The intended result is that students become more proficient in solving real world problems through the application of math concepts. Mathematics classrooms have moved beyond the days where calculators were the only technology tool at a teacher's disposal. Many classrooms now have laptops or iPads linking them to web-based tools. The way teachers use technology in their instruction has changed and will continue to change as new technologies become available.

The potential for success with digital technologies for mathematics education has been discussed for over two decades. Technology use in classrooms today is believed to have a positive effect on student engagement, basic skill development, problem solving, and overall attitude towards lessons. Drijvers (2013) conducted some of the first studies to examine the effect of computer usage on academic achievement in mathematics in 1988. He used computers to resequence a calculus course for first-year university students. The study clearly demonstrated the experimental group, exposed to a technology intensive course, outperformed a control group that was denied technology. This early study showed technology could be useful within the mathematics classroom. The 1988 study was not alone—other studies have indicated technology gave students an advantage. In a laptop study conducted in seventh-grade classrooms, teachers were presented with lesson plans, a pretest, and a posttest to give their students. The results of the posttest showed students who were allowed the use of technology performed significantly higher than students who did not have the advantage of laptops (Eyyam & Yaratan, 2014).

Researchers have found success is not limited to laptop programs. The results of a study conducted in 2017, which included 283 second-grade students from 87 classes within Sweden, indicated technology had a significant effect on second-grade students. Students were given computer-based mathematics instruction using tablets for a minimum of 19 hours of total instruction. The results demonstrated tablet-based intervention effectively improved basic arithmetic skills among low-performing students (Hallstedt et al., 2018). In another study involving tablets, the use of technology in mathematics resulted in student development and the use of higher-order problem-solving skills (Bray & Tangney, 2017). These studies showed technology can be an asset for teachers within the mathematics classroom.

Studies have indicated that how a teacher uses technology is just as important as it is for students to have the technology (Amer & Amer, 2018; Cakir et al., 2015; Drijvers, 2013; Robinson 2016). In a 2009 study, researchers examined the effects of homework software that provided instant feedback to students as they completed their work. Students were given a pretest and posttest that demonstrated students who had the advantage of immediate feedback from the online program outperformed students who received next-day feedback from a teacher (Roschelle et al., 2016). In a similar study of primary school students exposed to learning software, students benefited only when teachers and pupils fully implemented all of the features provided by the software program (Radovic et al., 2019).

Technology in English Language Arts

Technology usage within language arts classrooms has traditionally been reserved for publishing. Early research demonstrated benefits of increased student motivation and a shift toward student-centered environments (Robinson, 2016). As more and more text has become available through electronic media, researchers have examined the effect this may have on students. It was clear current students were increasingly taking advantage of electronic materials for reading in the classroom and outside of school. As students turned to electronic text more and more, researchers studied the effects electronic text might have. In particular, researchers have begun to examine reading comprehension for students who use electronic books rather than traditional text. Sackstein et al. (2015), in a study conducted with 71 students of which 55 were in high school and 14 were at university, determined no significant differences existed in comprehension scores between electronic and printed text. The researchers were not able to establish any difference in reading speed between the two different text types for two of the three student groups. Sackstein et al. concluded that students in the third student group actually read faster with electronic rather than printed text. Although the results suggested electronic devices such as laptops, tablets, or iPads do not necessarily lead to improved reading comprehension, they do suggest these devices can be introduced without lowering reading performance.

Similar research with younger students also showed positive relationships. In a 2016-17 study using 75 fourth-grade students, Kaman and Ertem (2018) studied the effect of digital text on students' comprehension, reading fluency, and attitudes toward text. They used a pretest to identify the 30 lowest-performing students and assigned 15 to an experimental group and 15 to a control group. The experimental group was allowed only electronic text, while the control group was given traditional printed text. Students read 14 texts, one per week, and were given a midtest and posttest. The researchers concluded a significant positive difference existed between the digital text group and the control group. The experimental group developed fluent reading skills, and their reading comprehension increased at a faster rate (Kaman & Ertem, 2018).

Not all research, however, has demonstrated a positive relationship between electronic sources and reading comprehension skills. Akbar et al. (2015) conducted a study in which they sought to establish a relationship between reading digital text and reading comprehension, attitudes, and fluency. The researchers concluded there was a negative effect on students' attitudes and reading comprehension when using digital text. However, the data indicated a positive relationship in reading fluency (Wilson & Czik, 2016). The contrasting research suggested, as with mathematics instruction, that the way the instructor used the technology in the classroom had a big impact on its effect.

Technology has also been found to influence writing by providing tools for quick and effective feedback (Robinson, 2016; Wilson & Czik, 2016; Zheng et al., 2013). A 2015 study of a device for every child program conducted in eight 8th-grade classrooms, the researchers measured the effects a writing feedback program had on student writing. Four classrooms were assigned to receive feedback from both their teacher and from an automated essay evaluation system. Four other classrooms were limited to feedback from their teachers only. The results showed students and teachers benefited from the automated system. Teachers reported the evaluation software assisted them in providing more valuable feedback to students. In addition, the results demonstrated that students, with the advantage of the combined feedback from their teacher, showed higher levels of writing persistence than their peers who only received teacher feedback (Wilson & Czik, 2016).

Although the body of research for the effects of technology in mathematics and language arts is mixed, it has showed a generally positive influence on student learning (Akbar et al., 2015; Drijvers, 2013; Eyyam & Yaratan, 2014; Hallstedt et al., 2018; Kaman & Ertem, 2018; Radovic et al., 2019; Roschelle et al., 2016; Sackstein et al., 2015; Wilson & Czik, 2016). It is reasonable to conclude, based on the research presented here, some exposure to technology in mathematics and language arts contributed to improved problem-solving skills, reading comprehension, fluency, and overall student attitude toward subject matter. The effect of technology saturation on this influence remains unknown. Many educational leaders have questioned whether this positive relationship would increase, maintain, or diminish if every student was given a device they could take home for use outside of the normal school day. Many educators believe technology saturation—found only in a 1:1 program—leads to an increase in student academic achievement.

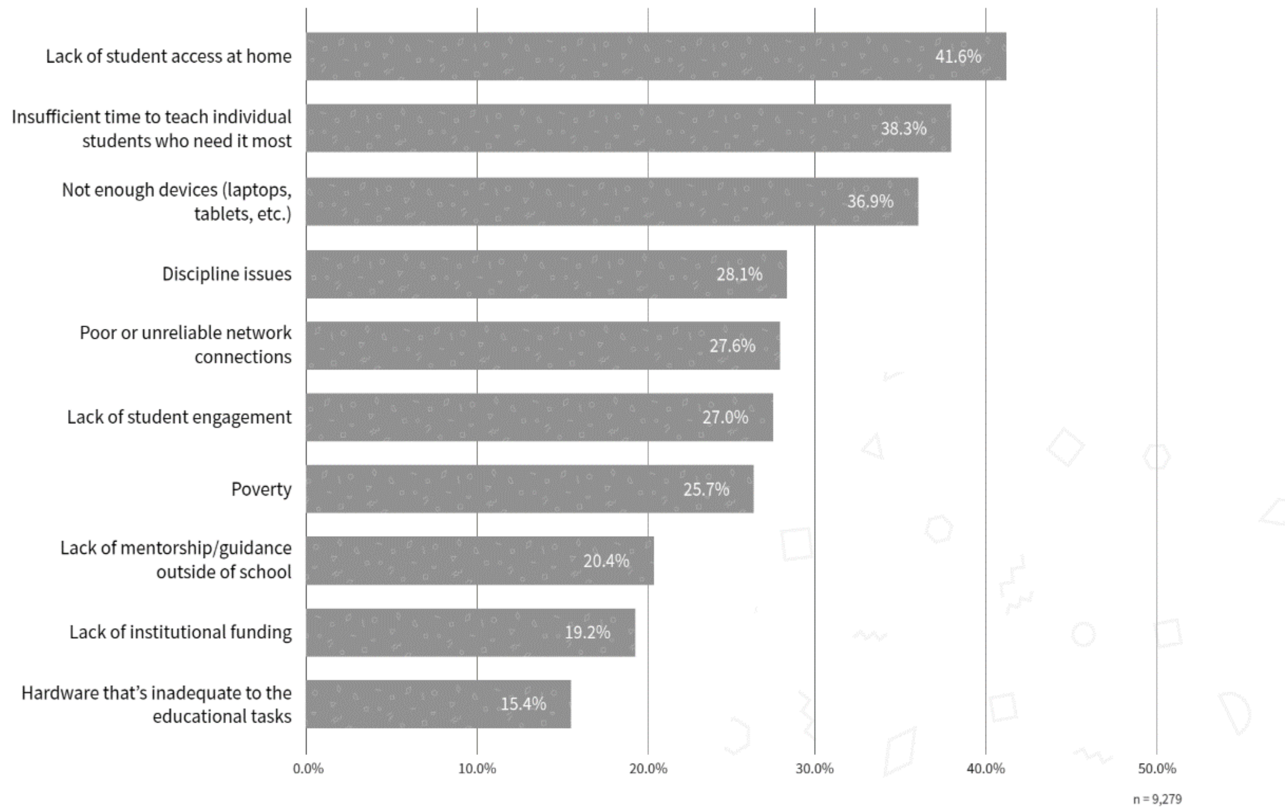
One-to-One Programs

Educational and political leaders have continued to look for ways to boost academic achievement for all learners (Blackford & Khojasteh, 2013; Howell, 2015; Jarvis, 2016). As the abovementioned studies showed, technology may be one tool for teachers, but only if investments are made to make these tools more available to students. A comprehensive survey completed in May/June 2018 determined classrooms needed more devices, not fewer. This survey included over 9,000 respondents, 94% of which came from the United States with the majority of participants from Texas, California, and Ohio. The survey included suburban (46.6%), rural (31.5%), and urban (26.8%) areas. Respondents were overwhelmingly classroom teachers and school administrators who stated the biggest obstacle to student learning was the lack of student access to technology at home. Third on the list was not enough devices in the classroom ("State of Digital Learning," 2018). Figure 1 presents the results of the survey. The takeaway from the survey was that educational leaders questioned whether their schools or districts should take the leap and go 1:1.

Research, thus far, on the effects of 1:1 initiatives within education is ambiguous. Tallvid (2016) noted, "There are arguments, in which 1:1-initiatives are considered as change-agents in efforts to transform teaching, particularly when encouraging student-centered approaches" (p. 503). However, other researchers suggested negative effects and did not recommend the saturation of technology that comes with 1:1 technology integration (Elliot-Dorans, 2018; Wurst et al., 2008). The following research provided evidence of contrasting results with 1:1 implementation. This was not an exhaustive list of the research that has been conducted, but it was a sampling of research to demonstrate the mixed outcomes produced as of yet.

Figure 1

Schoology Survey Results May/June 2018



Included in the body of research on the effects of 1:1 programs were two early, yet important case studies. The Berkshire Wireless Learning Initiative (BWLI) conducted in Massachusetts and the Texas Immersion Program initiated by the Texas legislature were large case studies designed early on to determine if a 1:1 technology initiative in public schools would result in higher student achievement. These two programs involved the saturation of laptop technology, with a device for every student (Texas Center for Education Research [TCER], 2009).

Berkshire Wireless Learning Initiative

The BWLI was a three-year pilot program consisting of five Massachusetts middle schools where every student and teacher were provided a laptop computer at the beginning of the

2005-06 school year. It is important to note that, in addition to devices, each classroom was equipped with a wireless Internet network so students could access online materials through their assigned laptops.

The program was designed to determine if a 1:1 laptop setting would affect student achievement, student engagement, classroom management, teaching strategies, and students' ability to conduct research or collaborate with peers about curriculum (Bebell & Kay, 2010). This $5.3 million initiative was funded through the school district budget, state funds, and local business contributions. The program was implemented from the 2005-2006 through the 2007-2008 academic school year. During the study, all students in sixth, seventh, and eighth grades were provided with Apple iBook G4 laptops for school and home use (Bebell & Kay, 2010).

The researchers for the BWLI case study used multiple methods to gather data. In addition to quantitative results, the researchers used teacher surveys, teacher interviews, student surveys, classroom observations, the analysis of current school records, and test scores to draw conclusions. The researchers themselves admitted, "There are limitless ways to summarize the variety of results and outcomes from such a study" (Bebell & Kay, 2010, p. 16). However, they concluded the 1:1 program had a significant effect for teachers, not only in teaching practices, but that it also resulted in benefits in their personal lives. In addition, the researchers demonstrated student engagement increased as a result of the continuous access to technology, although Grade 8 student performance reached its highest levels when the BWLI program was at its peak. The study did little to prove the 1:1 pilot program had a positive effect on test scores (Bebell & Kay, 2010).

Texas Immersion Pilot Program

The second case study resulted from the creation of the Technology Immersion Pilot (TIP) by the 2003 Texas legislature. The program was implemented in middle schools across Texas. The TEA invested more than $20 million to fund TIP at high-need middle schools through a competitive grant process (TCER, 2009). The TCER partnered with TEA for a four-year evaluation of the implementation and effectiveness of the TIP model. Researchers examined the effect of a 1:1 program on teachers and teaching, students and learning, and student academic achievement. They sought to answer the question: “What was the relationship between implementation and student academic outcomes” (TCER, 2009). The program allowed selected schools to choose from three different technology vendors: Dell Computer Incorporated, Apple Computer Incorporated, and Region 1 Education Service Center (TCER, 2009). The majority of schools, 15 of 21, chose the Dell computing package.

This study included 21 treatment schools and 21 control schools for a total of 42 campuses. Students within the selected schools were mainly economically disadvantaged and ethnically diverse. Data were collected through site visits, online surveys, paper and pencil surveys, student data gathered from the Texas Public Education Information Management System, the Academic Excellence Indicator System, student disciplinary actions, and the Texas Assessment of Knowledge and Skills (TAKS) assessments. Researchers reported the following results:

- TIP teachers grew in their technological proficiency at a faster rate than teachers from control group schools.
- TIP affected teachers’ perceptions of the schools’ culture.
- Students in the TIP program experienced intellectually more demanding work than students in control schools.
- TIP schools used technology applications more often in core-subject areas.

- TIP students participated in more small group classroom activities than students from control schools.
- TIP students reported more technical problems, increasing the work load for campus technicians, especially in the fourth year of the study.
- TIP students consistently had fewer disciplinary actions than students from control schools.

In contrast to these positive effects of the TIP program initiative, the TIP program was reported to have no statistically significant effect on student Texas Assessment of Knowledge and Skills (TAKS) Reading achievement levels. The program results were also mixed for TAKS Mathematics achievement levels, as Cohorts 2 and 3 reported a statistically significant effect while Cohort 1 demonstrated no significant effect. Finally, TAKS Writing scores actually favored the control schools, although not by a statistically significant amount (TCER, 2009).

Other 1:1 Research

The BWLI and TIP case studies showed some promising benefits to implementing a 1:1 laptop initiative, however, neither of them was able to establish whether it had a positive or negative impact on students' academic achievement. Other research since these two initial case studies has not yielded definitive answers.

A study conducted in an elementary school in Illinois examined how 1:1 technology affected participants' academic achievement and motivation in the classroom (Harris et al., 2016). Researchers investigated fourth-grade students from two different classrooms in the same Illinois Title I school. Harris et al. examined the effect of 1:1 technology on participants' academic achievement and motivation in the classroom. The researchers determined the technology had a considerable impact on student performance initially, although the effect dwindled throughout the year. In another study, Amelink et al. (2012) examined 1:1 usage within the engineering department of a large university. They monitored student use of the tablet PC within the engineering department at Virginia Tech. They examined relationships between student learning behaviors and tablet PC use. Amelink et al. found 1:1 implementation had increased students' learning behaviors in five of the six areas measured. They suggested future research into 1:1 programs was relevant and needed because it demonstrated technology affected student learning behaviors, which in turn increased achievement.

Other 1:1 programs have also seen success correspond with their technology initiatives. In a two-year study of upper elementary classrooms, researchers examined outcomes and data from 14 1:1 schools. Bebell and O'Dwyer (2010) not only concluded performance was higher for laptop users, but also presented evidence of a positive correlation between language arts performance and 1:1 student use. In another 1:1 laptop study consisting of California and Colorado school districts, Zheng et al. (2013) found elementary students showed improved English language arts achievement in a full laptop program. The researchers concluded the well-planned use of laptops daily can help improve literacy skills in at-risk learners. Finally, Spektor-Levy and Granot-Gilat (2012) presented evidence through a study of seventh- through ninth-grade students, that indicated students had a significant increase in 21st-century skills through the inclusion of laptops in classrooms. The study included two groups of students, totaling 181 participants. The two groups were given a complex task that required information processing and knowledge presentation. One group maintained continual access to laptop technology while the other group was denied access altogether. The results demonstrated the potential effects of learning when laptops were routinely made available for student use. These studies show some practical uses of 1:1 technology programs increased student achievement. However, not all 1:1 studies have shown the same level of success for students.

In contrast to the aforementioned research, "several studies point to lower student outcomes resulting from the distractions provided by always-present, hard to ignore, mobile devices like cell phones and laptops" (Langford et al., 2016, p. 3). In the modern world, temptation exists for students to venture off the intended educational path. Social media sites distract students when access to them is available. These distractions and others have led researchers to establish a direct correlation between use of digital devices and lower GPAs (Langford et al., 2016). Additionally, Tallvid (2016) noted teachers' lack of technology integration stemmed from their own lack of technical competence, benefits not being viewed as worth the effort required, insufficient teaching material, diminished classroom control, and lack of planning time.

These conflicting research findings led educators to question if technology would be more beneficial in some subject areas, grades, or student populations as opposed to others. In a study conducted in 2016, Harris et al. showed technology had a negative impact because of technological issues with the devices. Furthermore, the network slowed down instruction throughout the year, causing classes to get too far behind and having a big impact on curricula that built on previous concepts, such as mathematics.

The effects of increased distraction, lower GPA, and increased teacher reluctance to integrate once again led to the question of whether the cost of this technology was worth it. If students did not gain an academic advantage, then the time and resources used to implement a 1:1 initiative might be put to more effective use in other areas.

One of the most relevant examples of research sending mixed messages came from a study published in the *Journal of Educational Research*. This study included 21 middle schools that received laptops for every student and teacher. Shapley et al. (2011) discovered both positive and negative effects of 1:1 implementation. Students had an increase in technological proficiency, technology-based activities, and small group learning opportunities. However, there was no increase in students' math or reading achievement in class.

Systematic Reviews of 1:1 Technology Within Education

After searching for systematic reviews of 1:1 technology in education, I found three recent research studies. The first was a review of 1:1 computer projects published in peer-reviewed journals from 2005 through 2010 (Fleischer, 2012). The second study was a meta-analysis of 182 articles published between 1993 and 2013 (Sung et al., 2016). The third study, an international review, examined 145 publications during the ten years, 2006–2016 (Islam & Gronlund, 2016). The following sections focus on the purpose, methods, and findings of each of these three studies.

The aim of the first study was to review cross-disciplinary research in 1:1 computer projects. Fleischer (2012) initially identified 605 potential articles, but quickly removed 71 because of duplication. Then, Fleischer reviewed abstracts to ensure individual usage, empirical research, K-12, formal learning content, and generic usage. The researcher again reviewed the remaining 36 articles and selected 18. Fleischer reported most articles had multiple topics of focus including amount of usage, types of usage, experiences of learning, problems and issues, test scores, changed professional culture, teacher concerns, curriculum handling, and professional development programs. The most relevant results were found within test scores. Fleischer's systematic review indicated test scores increased moderately during the first year of implementation for writing and science. However, no growth was demonstrated in mathematics. The reviewer also made note of the low number of studies involving test scores. Finally, another observation important to current research was the lack of studies dealing with socioeconomic factors. Although the author of the review did provide several other findings, they did not relate to this study (Fleischer, 2012).

The second study of focus was a meta-analysis focused on 110 experimental and quasi-experimental studies published from 1993 to 2013. Sung et al. searched 4,121 abstracts related to mobile learning. They judged articles to determine their relatedness to teaching and learning with a mobile device. This yielded 925 articles which were then reviewed again. The reviewers excluded articles identified as conceptual analysis, research reviews, case studies, qualitative research, survey research, and pre-experimental studies, leaving 182 articles. Finally, Sung et al. searched those articles for the following inclusion criteria: application of mobile devices as a key variable, adequate information to calculate effect sizes, and learning achievement as a major dependent variable. At the end, they included 110 articles in data analysis. The meta-analysis produced effect sizes in eight categories: learning achievement, learning stage, hardware used, software used, implementation settings, teaching methods, intervention duration, and domain subjects. Three categories had results relevant to this paper's research including learning achievement, hardware used, and domain subjects.

Sung et al. found a significant effect size for learning achievement with mobile devices. The authors found "learning with mobiles is significantly more effective than traditional teaching methods that only use pen and paper or desktop computers" (2016, p. 257). This is significant for this paper's research because the study included the use of laptops, allowing mobility for students. The next significant finding, in the area of hardware used, showed handheld mobile devices had an even greater effect than laptops. In addition, Sung et al. found a high effect size for 1:1 technology in history, while language arts, mathematics, and science had medium effect sizes. It was important to note, in this meta-analysis, Sung et al. did not seek to determine the effect on students within differing socioeconomic levels or within different races or ethnicities.

The third review focused on international research investigating 1:1 computing in schools. Islam and Gronland (2016) used a five-step process to identify relevant studies: (a) locating papers published in leading journals, (b) going backward through three reviews of citations, (c) going forward through Internet and journal database searches, (d) reviewing citations of new literature found, and (e) checking references. This process initially found 297 publications and screened those through a concept matrix. After screening, 145 publications remained for further review.

Islam and Gronland (2016) categorized the found impacts of 1:1 programs into three broad categories: positive, negative, and no effect. The authors concluded that positive evidence for laptop programs dominated the research, especially by studies conducted in developed areas such as the United States. They also concluded that there were obvious gaps. One such gap was in the area of student achievement. The authors stated, "impact or effectiveness evaluation is still scarce" (p. 213).

There are common themes found within these three systematic reviews of 1:1 research. First, most studies reported an overall positive effect of 1:1 program implementation, especially about student engagement and the development of 21st-century skills. Second, the research was lacking in the effect 1:1 programs had on student achievement within specific subpopulations and within specific subjects. Finally, the research on the effect of 1:1 implementation on test scores was inconclusive and many times the results of different studies contradicted each another. Therefore, further research is needed to determine the effects 1:1 implementation could have on test scores for specific subpopulations within different subjects.

Synthesis of the Literature

The literature demonstrated the achievement gap between African American students and their White peers has frustrated educational leaders who continue to look for ways to help struggling students. At the same time, technology has made great strides in the last three decades and continues to change today. These advancements have led educational leaders to look to technology as one way to level the playing field for all students. The saturation of Internet-capable devices within classrooms through the implementation of 1:1 initiatives has become a growing trend worldwide. The advancements in Web 2.0 technology tools have made technology within classrooms more interactive and therefore, more applicable for instruction and peer-to-peer collaboration. These same Web 2.0 advancements have led to complete LMSs that allow assignments to be posted, completed, peer reviewed, graded, and provided feedback all online. Further, this has made the implementation of 1:1 programs attractive to school leaders.

The research on 1:1 technology programs, thus far, is mixed and sometimes even contradictory with some programs demonstrating positive effects on student learning, while others find no significant differences from students who do not have access to such technology. The researchers from early studies such as the BWLI and the Texas Immersion Pilot Program found positive impacts on technology skills and student engagement, but failed to establish any significant relationship between student academic success and 1:1 technology implementation. Later authors of systematic reviews reported a low number of 1:1 studies that addressed test scores and socioeconomic factors. Among available studies, researchers were not able to determine the effect 1:1 technology initiatives might have on African American students' performance on standardized test scores.

The literature presented in this chapter demonstrates that a need exists for further research to support 1:1 implementation within schools and districts. Research has consistently called for additional studies on the impact of such initiatives. Hakansson Lindquist (2013) concluded her findings with the following statement: "The effects on students' learning and the spin-off effects on the school as an organization are important questions for future research" (p.

645). Bebell and O'Dwyer (2010) found a lack of research on the effects of 1:1 technology on minority groups, such as African Americans, and specific academic subjects. Authors of these studies acknowledged questions still remain and require further research of the effects of 1:1 technology. Taken as a whole, these studies also demonstrate that research on how 1:1 implementation affects African American students' academic performance in English I and Algebra I would be beneficial.

As educational leaders look to the technology debate, they need data to guide their decisions. Data showing (a) how to effectively implement 1:1 technology, (b) which student populations benefit the most from technology, (c) which subjects are enhanced by technology, and (d) what impact technology use has on student success are necessary for decision making within schools and districts across Texas. Clear evidence would give superintendents and principals more confidence as they make decisions regarding technology and how it would benefit their students. Although this study will not answer all of these questions, it provides evidence of the effects a 1:1 technology program had on student academic achievement within English I and Algebra I of African American students, a historically underperforming subgroup.

Chapter 3: Research Method

I used a quantitative causal-comparative research to compare mean differences between ninth-grade African American students who participated in and those who did not participate in a 1:1 technology program and their subsequent achievement. I used standardized test scores from both the Algebra I EOC exam and the English I EOC exam to demonstrate student academic achievement. The purpose of this research was to present evidence on the effects that 1:1 technology initiatives may have on the academic achievement of African American students in Algebra I and English I at the high-school level. Academically, African American students perform lower than their peers. Educational leaders continue to search for ways to close this achievement gap. Through this quantitative study, I determined if there was a significant statistical or practical difference in student performance on the Algebra I and English I EOC exams when comparing nine campuses with a 1:1 technology program to nine campuses without a 1:1 technology program. I designed this study to determine if 1:1 technology was a possible solution for narrowing the achievement gap between African American students and their White peers. The data contributed to the evidence needed by school superintendents to make informed decisions on whether to invest the large amount of resources required to implement a 1:1 technology program in their district.

Problem Statement

The achievement gap between African American and White students continues to exist today (Bowman et al., 2018). Educational leaders search for ways to close the gap and improve the academic achievement of all students. At the same time, there is a clear push for more technology integration in our public schools. Many of these leaders have begun to look at technology as one way to help close this gap (Bjerede & Kruger, 2015). Technology initiatives are being implemented to raise academic achievement for all students (Richardson et al., 2013). However, technology initiatives provide an Internet-capable device for all students at a high cost to schools and districts. Educational leaders need evidence such an investment will help the students who need it most.

Research Questions

Q1: How does participation in a 1:1 technology program affect academic achievement in Algebra I among African American high school students?

Q2: How does participation in a 1:1 technology program affect academic achievement in English I among African American high school students?

Research Hypotheses

HO: No significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam.

HA: Significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam.

HO: No significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC English I exam.

HA: Significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC English I exam.

Research and Design Method

Research design starts with formulating research objectives for the study (Muijs, 2011). To know which research methods to employ, the researcher must first identify the reason for researching. In developing the research design, I considered the hypotheses and problem of practice. There are three predominant research study approaches to consider: qualitative, quantitative, or mixed-methods approach (Creswell, 2009). The research design for this study was a quantitative research methodology. I chose a causal-comparative research design to determine if 1:1 programs significantly affected student achievement on the Algebra I and English I EOC exams.

Causal-comparative designs allow researchers to discover possible causes by making comparisons between two preexisting groups (Terrell, 2016). An independent variable and at least one dependent variable are identified to determine if a relationship exists between the two. The independent variable for this study was participation in a 1:1 technology initiative found at high schools A through I as shown in Table 1. The dependent variables are the Algebra I and English I EOC standardized test scores. The causal-comparative research design was appropriate because it allowed me to determine if the independent variable significantly affected the dependent variable (Terrell, 2016). This provided evidence of whether 1:1 technology had an effect on the academic achievement of African American students in Algebra I and English I at the high-school level.

Statistical Significance

I looked for statistical significance in the relationship between 1:1 technology programs and student academic achievement. A *p*-value of < .05 was considered statistically significant, demonstrating there was at least a 95% chance the relationship between participation in a 1:1 technology program and academic success was not by chance. Although a *p*-value of less than .05 establishes a relationship, it does not demonstrate the strength of the relationship (Muijs, 2011). For this reason, I sought to establish practical significance.

Practical Significance

Practical significance is important because it is a concept that moves beyond statistical significance and *p*-values. Finding practical significance is essential for investigating educational interventions and is often a more stringent criterion than statistical significance (Peeters, 2016). Typical studies have used statistical significance to determine the relationship between two sets of data. Tested hypotheses have been accepted or rejected based on a *p*-value. When a *p*-value of less than .01 or less than .05 is determined, the result is deemed statistically significant at a 99% or 95% confidence level, respectively. However, there are methods of helping to ensure the measured relationship reaches these levels of statistical significance. For example, the *p*-value can be made smaller by dramatically increasing the sample size. This increase in sample size increases the statistical significance in any relationship which may be present (Kalinowski & Fidler, 2010). Therefore, many researchers are moving beyond statistical significance and looking for practical significance. This is because the threshold for practical significance cannot be overcome by simply increasing a sample size (Peeters, 2016). A study may find a significant relationship between two variables, such as participation in a 1:1 technology initiative and academic achievement on an EOC standardized test. This would demonstrate a relationship does not exist by chance. However, it does not demonstrate the result has a strong enough relationship to justify the cost of a 1:1 initiative. By establishing practical significance, it can be determined whether the relationship is substantial enough to make expenditures for 1:1 technology practical.

Although there are multiple ways to determine practical significance, I used the Cohen's *d* to determine if the found relationship was strong or weak (Muijs, 2011). I accepted a Cohen's *d* of .50 or greater as a strong relationship.

Population and Setting

This quantitative causal-comparative research study occurred in 18 Texas high schools, each of which was compared to other campuses within their state-identified campus group. I selected these high schools because of their 1:1 technology program or for their close comparison to campuses with a 1:1 technology program. In Texas, campus comparison groups are used to determine distinction designations. Schools and districts find campus comparison groups useful for comparing their own performance to peer campuses ("2016 Accountability Manual," 2016). I used schools from the same campus comparison group to ensure similar demographics. This limited other factors that influence academic achievement, such as socioeconomic levels. The demographic details of each of the schools are presented in Table 1.

Table 1

Demographics of Participating High Schools

High School	Enrollment	% African American	% Economically Disadvantaged
A	845	88.9	62.1
B	813	82.0	73.8
C	606	65.3	87.3
D	942	63.9	73.2
E	760	53.7	72.8
F	827	51.0	69.9
G	1,123	54.1	75.8
H	1,759	40.6	75.0
I	2,190	33.3	78.2
1	1,358	69.9	89.1
2	883	69.4	80.3
3	1,194	58.1	60.0
4	1,502	41.3	80.2
5	1,070	74.3	86.4
6	868	36.9	67.7
7	1,205	67.0	65.4
8	1,865	36.4	70.0
9	1,304	51.8	74.2

Note. The nine high schools with 1:1 technology programs are labeled A through I. The nine high schools without 1:1 technology programs are labeled 1 through 9.

I conducted an independent *t* test to determine if there were any significant statistical differences between schools in enrollment, the African American population percentage, and the percentage of economically disadvantaged students. I was prepared to conduct a Bonferroni correction if I found a significant statistical difference.

I selected nine 1:1 high schools for this study and identified them as schools A through I on Table 1. All schools selected had an African American population of 33.3% or higher with the highest percentage of African American students at 88.9%. The 1:1 high schools included in this study had an economically disadvantaged population range of 62.1% to 87.3%.

Sampling Method

When individuals can be randomly assigned to groups, it results in a true experiment (Creswell, 2009). However, in many experiments a convenience, or nonrandom, sample is used. This is “probably the most commonly used sampling method in educational studies at present” (Muijs, 2011). I used a convenience sample because I needed to use naturally formed groups such as a school, a classroom, or a family unit (Creswell, 2009). I randomly sampled students from each school enrolled in Algebra I and English I classes existing within the 18 selected Texas high schools.

Materials, Instruments, and Data Collection

The unit of analysis for this study was individual students and their EOC exam scores from the 18 Texas high schools. The participants were ninth-grade African American students enrolled in Algebra I or English I during the 2016-17 school year. The participants were required to take the EOC exam for their enrolled course.

The Algebra I EOC exam was given to Algebra I students toward the end of their Algebra I course. Students had to pass this exam to demonstrate proficiency in Algebra I. Students who did not pass this exam would not receive credit for the course. By law, school district administrators in Texas had to administer the exam to students enrolled in Algebra I. Data are collected and reported back to campuses and communities. I requested individual student data from the TEA for each of the 18 identified high schools.

Similarly, the English I EOC exam was given to students towards the end of their English I course. Students must pass this exam to demonstrate proficiency and therefore, receive credit for the course. High schools in Texas are required to administer the annual test to students enrolled in English I. Like the Algebra I exam, the results of the English I EOC are collected and reported back to campuses and communities. I requested individual student data from the public education information management system (PEIMS) for each of the 18 identified high schools.

Once I received the data, I used SPSS to analyze it. SPSS software randomly selected students from each high school and ran a multivariate analysis of variance (MANOVA) to determine the effect of 1:1 technology initiatives on student academic achievement. I used Algebra I and English I EOC standardized test scores from ninth-grade students as data.

In addition to determining the statistical significance 1:1 technology may have on academic achievement, I wanted to determine if there was any practical significance. Although there are multiple ways to determine practical significance, I used the Cohen's *d* to determine if the found relationship was strong or weak (Muijs, 2011). I accepted a Cohen's *d* of .50 or greater as a strong relationship.

Variables

I indentified the independent variable, also referred to as a predictor, was participation in a 1:1 technology initiative (Muijs, 2011). The dependent variable, also referred to as an effect variable or outcome variable, was students' achievement scores on Algebra I and English I EOC exams given by the state of Texas to high school students (Muijs, 2011). I collected the dependent variable data from TEA.

Control variables must be accounted for within a quantitative research design. These variables are controlled for the researcher to measure the intended independent variable (Muijs, 2011). Control variables accounted for in this study were race, economic disadvantage, and curriculum. In this study I examined the academic achievement of African American students at 18 Texas high schools; I reviewed only African American students' scores. I chose the 18 Texas high school campuses from the same state campus comparison group and chose them specifically because of their similar enrollment of economically disadvantaged students. Finally, all Algebra

I and English I classes in the state of Texas have their curriculum mandated through the Texas Essential Knowledge and Skills (TEKS) curriculum. The Algebra I and English I EOC exams were designed to measure a student's understanding of this mandatory curriculum.

- Dependent Variable 1 - academic achievement in Algebra I.
- Dependent Variable 2 - academic achievement in English I.
- Independent Variable - participation in a 1:1 technology initiative

Data Collection

The state of Texas requires students to pass both the Algebra I and English I EOC exams to receive credit for each class (TEA, 2017-18). I selected 18 Texas high schools to participate in this study. I chose the first nine high schools based on two criteria: They had a 1:1 laptop initiative within their schools, and they had a high population of African American students. I selected the other nine high schools because of their demographic similarities to the first nine campuses and because they did not have a 1:1 technology initiative. This allowed me to include nine schools that had a 1:1 technology initiative and nine that did not. The 18 schools selected were in the same state-identified campus comparison group. This allowed me to be confident the schools were similar in student population and demographics. I collected test data in the form of individual student scale scores from the 2017-18 STAAR EOC exams for ninth-grade African American Algebra I and English I students at each of the 18 participating high schools.

I conducted an independent *t* test to determine any significant mean differences between the independent variable and dependent variables. In addition to an independent *t* test, I used a Cohen's *d* test to determine the strength of any relationship that was found. This allowed me to establish whether practical significance existed.

Instrument and Validity

The state of Texas requires all Algebra I and English I students to demonstrate proficiency through a standardized exam. The State of Texas Assessment of Academic Readiness (STAAR) exam is a requirement for students in Grades 3 through Grade 8, English I, English II, Algebra I, Biology, and U.S. History (TEA, 2017-2018). Therefore, the Texas legislature has taken steps to ensure the validity of the tests, including external validity studies.

Validity includes three distinct aspects: content validity, criterion validity, and construct validity (Muijs, 2011). Content validity refers to whether the exam accurately measures the content it is meant to measure. The TEA performed a content validity study ,to determine the correlation between STAAR EOC exams and corresponding course performance. Although the study included all STAAR EOC exams, my research focused only on the Algebra I and English I results in the study. There was a sample size of 59,903 students who took the English I reading exam. The data indicated 80% of students who scored *satisfactory* earned a B or better in corresponding course work, while 94% of students who scored *advanced* scored a B or better in corresponding course work with a 0.047 correlation (TEA, 2017-2018). I cautiously recognized that grading policies were not standardized across the state. Each school district or campus sets their grading policies which may have influenced the correlation result.

Criterion validity measures how closely an instrument relates to other measures or predicts an outcome. This can be referred to as predictive validity (Muijs, 2011). To assure test validity, Texas Education Code (TEC) section 39.0242 requires that linking studies should be conducted to determine a link on student performance of STAAR EOCs within the same content area. My study focused on the link between Algebra I and Algebra II EOC performance and the link between English I EOC and English II EOC performance. TEA's study included a sample size of 17,159 students and demonstrated a 0.67 correlation existed between performance on English I STAAR EOC and performance on English II STAAR EOC exams (TEA, 2017-

18). Likewise, the TEA study looked for a correlation between Algebra I EOC and Algebra II EOC exams. The study included 22,075 algebra students, finding a 0.68 correlation between the Algebra I STAAR EOC and the Algebra II STAAR EOC exams (TEA, 2017-18). I found these studies on the TEA website at https://tea.texas.gov/staar/vldstd.aspx and they served to establish the validity of the Algebra I EOC and English I EOC exams as valid instruments in this study.

Ethical Considerations

The Abilene Christian University's (ACU's) Institutional Review Board (IRB) approved this causal-comparative research design prior to data collection. The study posed no risk to participants because I collected only standardized test scores after mandatory testing instruments had been administered. I recognized ethical concerns by incorporating an ex post facto design. The Algebra I and English I exams, which are used to measure student academic success, are given annually and were administered regardless of the present study.

Researcher's Role

To reduce any threats to the integrity of the study I had no financial, personal, or supervisory connection to the selected participants. I was not a participant in the study. Finally, when the ACU's IRB granted approval (see Appendix A) to proceed with the study, I sent an informed consent form to the TEA to request the relevant data (Creswell, 2009).

Conclusion

The desire to integrate technology into the classroom is not a new concept. Since 1996, federal, state, and local agencies have invested more than $10 billion to acquire and integrate computer-based technologies into public schools (O'Dwyer et al., 2005). Teachers have long believed technology integration not only prepares students for success in an ever-growing technological workforce, but it also helps to engage students. At the same time, African American students continue to underperform academically when compared to their peers. The resulting performance gap continues to be a concern for many educational leaders (Blackford & Khojasteh, 2013). As educators continue to look for ways to close the achievement gap, many schools and districts have incorporated technology to help increase engagement and student performance in the classroom.

As educational leaders continue the technology debate, they need data to help support their decisions. Data showing (a) how to effectively implement 1:1 technology, (b) which student populations benefit the most from technology, (c) which subjects are enhanced by technology, and (d) what impact technology use has on student success are necessary for decision making within schools and districts across Texas. Clear evidence would give superintendents and principals more confidence about the decisions they make regarding technology and how it would benefit students. I designed this study to contribute data on the effects 1:1 technology initiatives have on African American students' academic achievement.

Chapter 3 outlined the research design, presenting design, and methodology, population and sampling methods, instruments used to analyze data, and ethical considerations. The next chapter details a description of the data analysis and results of the study.

Chapter 4: Results

There continues to be an achievement gap between White and African American students. In an effort to close this gap, educational leaders across the United States are increasing technology in classrooms to raise the student achievement for all students. There is a clear trend toward costly 1:1 technology programs within education without evidence of its effect on student learning. The purpose of this study was to determine if a 1:1 technology programs increased student achievement for African American students and helped to close the persistent achievement gap.

This study focused on 18 high schools in Texas; nine with a 1:1 computing program where every student received a laptop, and nine schools where students were not part of a 1:1 program. I compared schools with a 1:1 program to schools without the 1:1 technology to demonstrate the effects this level of technology had on student achievement through analysis of EOC exam results for English I and Algebra I. I analyzed data to determine normality within data sets. Then I ran two independent *t* tests to ascertain if any statistical significance was present. Finally, I ran a Cohen's *d* to determine practical significance.

Research Questions

I established two research questions to guide the study:

Q1: How does participation in a 1:1 technology program affect academic achievement in Algebra I among African American high school students?

Q2: How does participation in a 1:1 technology program affect academic achievement in English I among African American high school students?

Hypotheses

Ho: No significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam.

HA: Significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam.

HO: No significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC English I exam.

HA: Significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC English I exam.

Population

In addition to using schools from campus comparison groups formulated by the state of Texas, I conducted *t* tests to ensure there was not a significant statistical difference between schools with a 1:1 program and schools without a 1:1 program. I conducted analyses for overall enrollment, percentage of African American population, and percentage of economically disadvantaged students. The *t* test for enrollment resulted in a *p*-value of .198. This finding demonstrated there was not a significant statistical difference between high school enrollments. The *t* test for African American population resulted in a *p*-value of .774. This finding demonstrated there was not a significant statistical difference among the percentage of African American students enrolled at the 18 high schools. I conducted a *t* test for the percentage of economically-disadvantaged students enrolled. The resulting *p*-value was .114. This finding demonstrated there was not a significant statistical difference between the percent of economically-disadvantaged students enrolled at the included high schools. Since there was no significant statistical difference between the schools selected in regard to enrollment, percentage of African American population, or percentage of economically-disadvantaged students, I did not conduct a Bonferroni correction.

Table 2

Independent Samples Test of Demographics of Participating High Schools

		Levene's Test for Equality of Variances								
		F	*Sig.*	*t*	*Df*	*Sig. (2-tailed)*	*M Diff.*	*SED*	*Lower*	*Upper*
Enrollment	Equal Variances assumed	1.808	.198	-.753	18	.462	-153.778	204.25270	-586.77415	279.21859
	Equal variances not assumed			-.753	12.960	.465	.153.778	204.25270	-595.17758	287.62203
African/American	Equal variances assumed	.085	.774	.393	16	.700	3.0778	7.83257	-13.56934	19.72490
	Equal variances not assumed			.393	15.509	.700	3.0778	7.83257	-13.56934	19.72490
EcoDis	Equal variances assumed	2.7494	.114	-.173	16	.865	-.68899	3.97954	-9.12513	7.74736
	Equal variances not assumed			-.173	16	.865	-.68899	3.97954	-9.12513	7.84093

Normality

To determine normality, I ran a Kolmogorov-Smirnov and a Shapiro-Wilk test. Table 2 shows that these tests resulted in a *p*-value of .000 for Algebra I and English I data sets. With this finding, the null hypothesis of normal distribution was rejected even at a 99% confidence interval. Because the data sets were large and non-normality is common within large data sets, histograms were next used to visually observe both data sets.

Table 3

Test of Normality

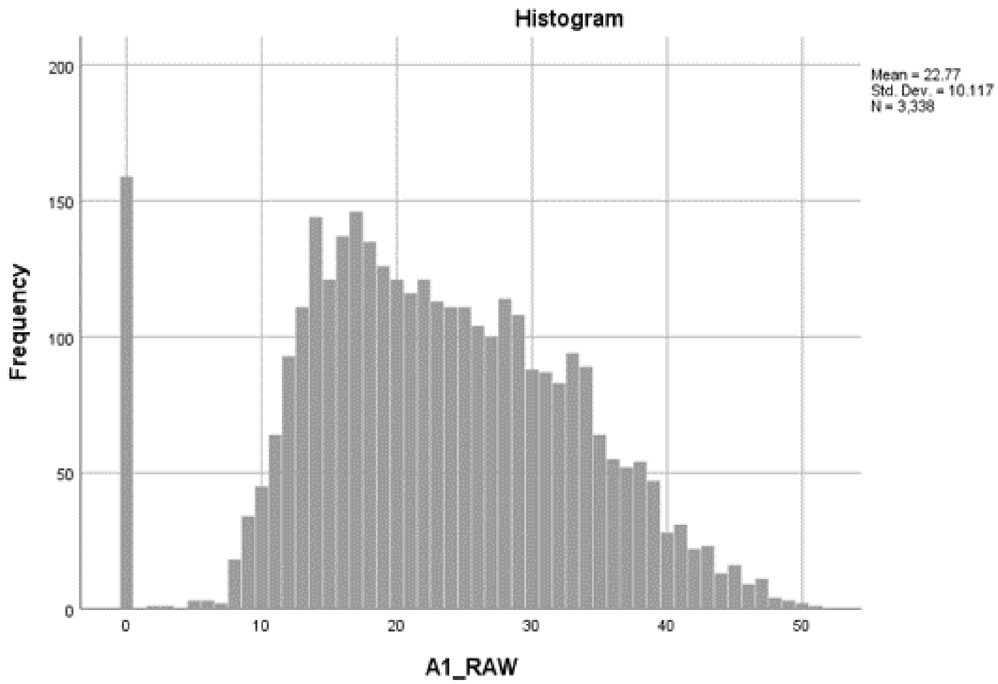
Statistic	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	df	*Sig.*	*Statistic*	*df*	*Sig.*	*Statistic*
A1_RAW	.048	3338	.000	.986	3338	.000
E1_RAW	.049	4395	.000	.972	4395	.000

a. Lilliefors Significance Correction

Algebra I raw scores were slightly skewed to the right. The visual representation also demonstrated a large number of students scored a zero. Several factors can cause a student to score a zero other than missing every question. One such factor is marking an answer sheet to score even though the student was absent, or a student not transposing his answers from the test booklet onto the Scantron answer document. For these reasons, I removed scores of zero from the data sets for Algebra I raw scores (see Figure 2).

Figure 2

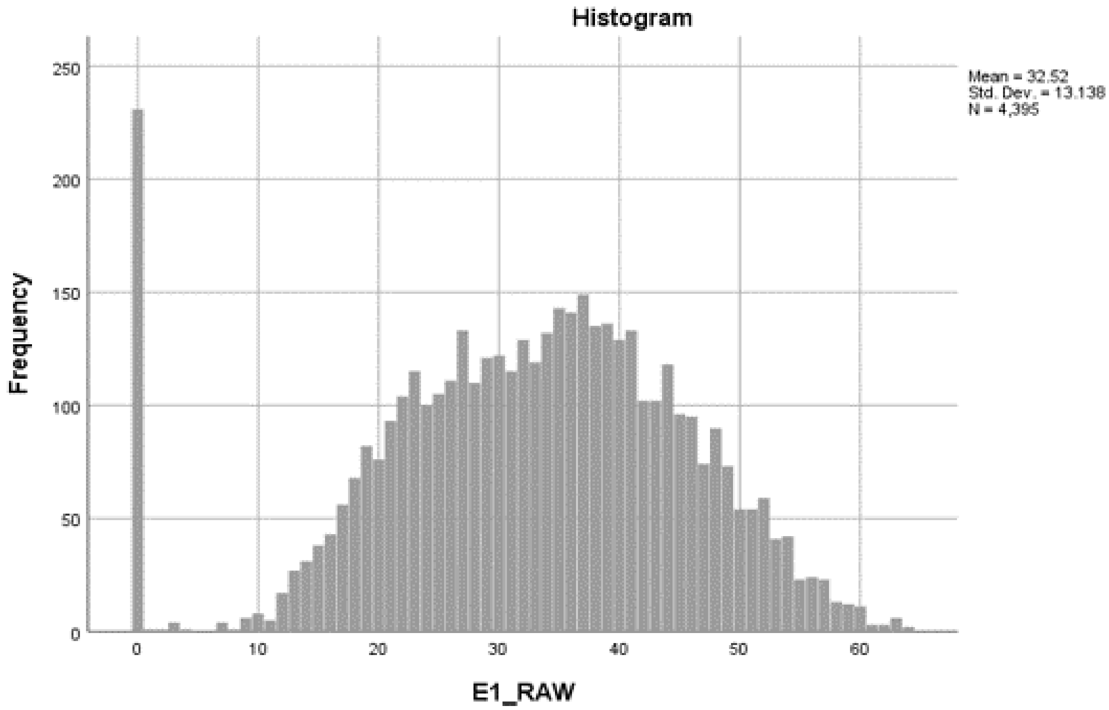
Algebra I Raw Score Data



I also reviewed English I raw scores visually using a histogram. These scores appeared to follow a more normal distribution than the Algebra I scores. However, they also demonstrated a large number of students scored a zero. For the same reasons as for Algebra I data, I removed all scores of zero from the data sets for 1:1 program schools and schools without a 1:1 program (see Figure 3).

Figure 3

English I Raw Score Data



Once I removed zeros from all data sets, I ran the Kolmogorov-Smirnov and Shapiro-Wilk tests again. As shown in Table 3, the tests demonstrated that removing scores of zero did not change the results of the Kolmogov-Smirnov or Shapiro Wilk test. However, the data sets were still large and I examined normality visually.

Table 4

Test of Normality Excluding Zero Scores

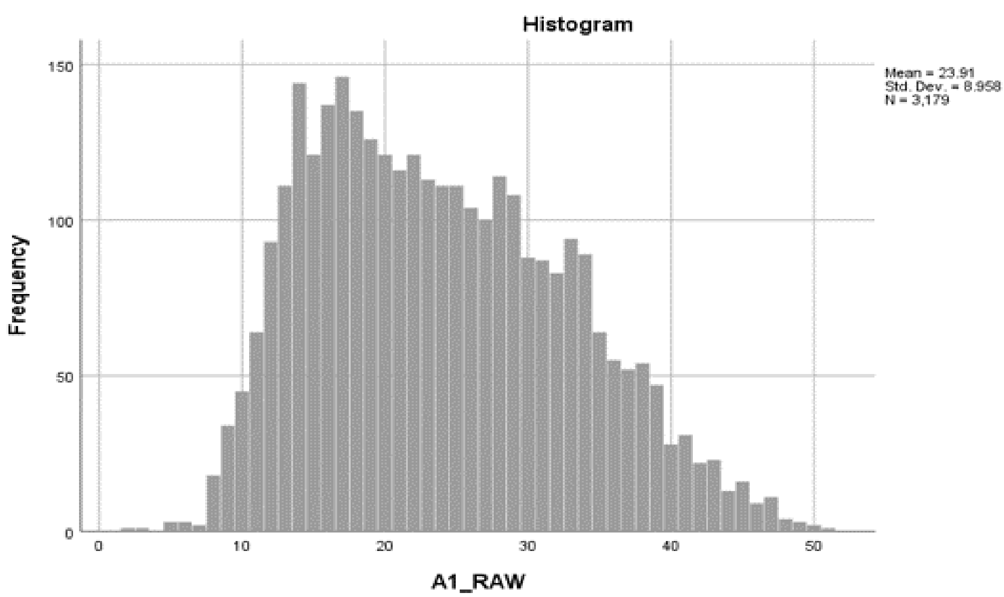
Statistic	Kolmogorov-Smirnova			Shapiro-Wilk		
	Df	*Sig.*	*Statistic*	*df*	*Sig.*	*Statistic*
A1_RAW	.080	3179	.000	.975	3179	.000
E1_RAW	.043	4164	.000	.993	4164	.000

a. Lilliefors Significance Correction

To look at distribution visually, I constructed a histogram of the Algebra I data set without zero scores included. The histogram shows similar results to the previous data set with scores of zero included. The Algebra I EOC scores were slightly skewed to the right as shown in Figure 4.

Figure 4

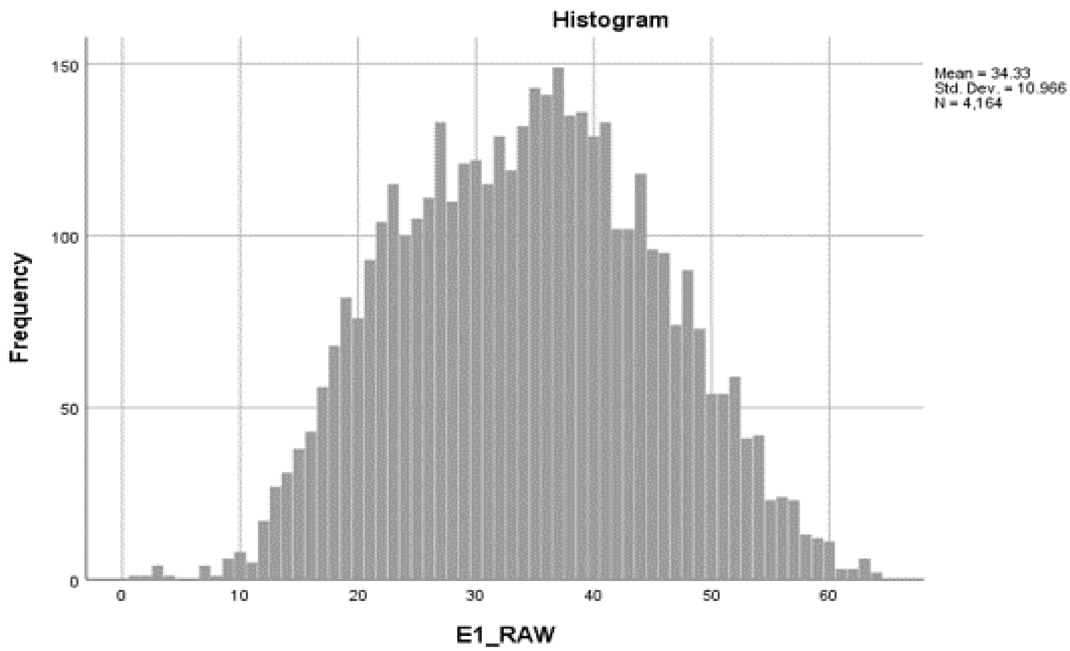
Algebra I Data Excluding Zero Scores



Likewise, I once again looked at English I score results visually after I removed zero scores from the set. The English I EOC scores appeared to be much closer visually to a normal distribution as demonstrated in Figure 5. Even with the slight positive skewness of Algebra I, the large sample sizes of 3,179 Algebra I students, and 4,164 English I scores allowed me to run an independent *t* test (Poncet et al., 2016).

Figure 5

English I Data Excluding Zero Scores



Results for Statistical Significance

When conducting an independent *t* test to determine statistical significance, a 95% confidence interval is desired before considering to reject the null hypothesis. When multiple *t* tests are conducted with the same set of data, a Bonferroni correction must be done to account for the increased potential of a type I error. The Bonferroni correction resulted in the adjusted *p*-value used for rejecting the hypothesis as .025 or a 98.5% confidence interval. This new *p*-value was used to determine any statistical significance within this study.

I ran an independent *t* test with the independent variable of 1:1 technology programs and a dependent variable of Algebra I raw scores. Table 5 shows the group statistics for Algebra I.

Table 5

Algebra I Group Statistics

PRG1_1 A1_RAW		*n*	*M*	*SD*	*SEM*
	Y	1560	22.20	8.310	0.210
	N	1619	25.55	9.251	0.230

The initial group statistics showed that for the 3,179 scores found within the Algebra I data set, 1,560 were within a 1:1 technology program and 1,619 were not within a technology program. An independent *t* test showed a difference between mean values. Students who had *not* participated within a 1:1 program scored consistently higher than students who did have 1:1 technology available. The independent *t* test showed a *p*-value of .000, demonstrating even at a 99% confidence level the difference was statistically significant. Therefore, I rejected the null hypothesis that no significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam. The alternative hypothesis was accepted—that significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC Algebra I exam. Table 6 shows the results of the independent *t* test.

Table 6

Algebra I Independent Samples Test

	Levene's Test for Equality of Variances								
A1 _ Raw	*F*	*Sig.*	*t*	*Df*	*Sig. (2-tailed)*	*Mean Diff.*	*SED*	*Lower*	*Upper*
Equal variances assumed	27.363	0.00	-10.723	3177	0.000	-3.348	0.312	-3.961	-2.736
Equal variances not assumed			-10.745	3161.56	0.000	-3.348	0.312	-3.960	-2.737

I ran an independent *t* test with the independent variable of 1:1 technology programs and a dependent variable of English I raw scores. Table 7 shows the results of this test.

Table 7

English I Group Statistics

PRG1_1 E1_RAW		*n*	*M*	*SD*	*SEM*
	Y	2053	33.03	10.910	0.241
	N	2111	35.59	10.873	0.237

The initial group statistics showed that for the 4,164 scores within the English I data set, 2,053 were within a 1:1 technology program, while 2,111 were not included within a technology program. An independent *t* test showed a difference between mean values (see Table 8). Students who had not participated within a 1:1 program scored consistently higher than students who did have 1:1 technology available. However, the independent *t* test showed a *p*-value of .693, demonstrating even at a 95% confidence level, I accepted the null hypothesis of no significant mean differences existing between African American students who participated in a 1:1 technology program and those who did not. Although the group statistics demonstrated a discrepancy in academic achievement between students within and not within a 1:1 technology program, the difference was not statistically significant.

Table 8

English I Independent Samples Test

	Levene's Test for Equality of Variances								
E1 _ Raw	*F*	*Sig.*	*t*	*Df*	*Sig. (2-tailed)*	*Mean Diff.*	*SED*	*Lower*	*Upper*
Equal variances assumed	0.156	0.693	-7.600	4162	0.000	-2.566	0.338	-3.228	-1.904
Equal variances not assumed			-7.600	4157.94	0.000	-2.566	0.338	-3.228	-1.904

Results for Practical Significance

Because statistical significance within an independent *t* test can be influenced by large sample sizes, it was important to also test for effect size. The effect size can be measured through an assessment for practical significance by completing a Cohen's *d* test. Finding practical significance is essential for investigating educational interventions and is often a more stringent criterion than statistical significance (Peeters, 2016).

The formula for the Cohen's *d* test is as follows: *d* = (mean for group A - mean for group

B)/ pooled standard deviation. The formula for the pooled standard deviation is as follows: *psd* = (*SD* of group 1 + *SD* of group 2) / 2. Guidelines follow for determining whether the results suggest a strong to a weak effect size.

- 0 - 0.20 = weak effect
- 0.21 - 0.50 = modest effect
- 0.51 - 1.00 = moderate effect
- > 1.00 = strong effect (Muijs, 2011)

The mean and standard deviation for Algebra I students participating in a 1:1 program and those who did not participate in a 1:1 were shown in Table 5. When those numbers are placed in the Cohen’s *d* formula, the following result is produced: Cohen's *d* = (25.55 - 22.2) ⁄ 8.793097 = 0.380981. This finding indicated that the 1:1 programs in which students participated had a modest effect on student academic achievement. As the *t* test demonstrated, there was a negative effect on student achievement.

The mean and standard deviation for English I students participating in a 1:1 program and those who did not were shown in Table 7. When those numbers were placed in the Cohen’s *d* formula, the following result was produced: Cohen's *d* = (35.59 - 33.03) ⁄ 10.891516 = 0.235045. These results demonstrated that although the 1:1 programs did not have a significant effect, a modest practical effect may exist. However, as the means in Table 8 showed, this would also have a negative effect on student achievement.

Conclusion

This research study included 3,119 Algebra I and 4,164 English I scores of African American students. Of those 7,283 Texas students, 3,613 students participated in a 1:1 technology program in which every student received a laptop, whereas 3,730 students tested did not participate in a 1:1 program. I performed independent *t* tests. The *t* tests demonstrated that although the 1:1 program had no significant effect on English I academic achievement, it did have a negative effect on Algebra I scores at a statistically significant level. A Cohen's *d* test further demonstrated the effect size was modest on Algebra I scores (Muijs, 2011).

In Chapter 5 these findings, limitations, and recommendations for future research will be discussed.

Chapter 5: Discussion

Problem, Purpose, & Methodology

As an achievement gap between White and African American students persists in Texas schools and across the United States, educators are increasing the availability of technology to students with 1:1 laptop programs in an attempt to close this learning gap. These laptop initiatives are propelling educational change with the intent of providing benefits that include improving academic achievement for all students (Richardson et al., 2013). However, evidence of the effects 1:1 technology has on student learning is needed to help educational leaders make informed decisions on program implementation. The specific problem I examined in this quantitative study was whether 1:1 technology programs increase student academic achievement, thereby helping to close the achievement gap between African American and White students.

This study was designed to determine if African American students at high schools with 1:1 technology programs performed higher academically than African American students who did not participate in a 1:1 initiative. I sought to produce evidence for school leaders concerning achievement of high school students within 1:1 technology programs and those who did not participate in such a program. I designed the study to identify whether there was a significant statistical or practical difference in English I and Algebra I standardized test scores for ninth-grade African American public-school students who participated in a 1:1 technology initiative versus those who did not.

The research design for this study was a quantitative research methodology. I chose a causal-comparative research design to determine if 1:1 programs significantly affected student achievement on the Algebra I and English I EOC exams. The study included 18 schools, nine with a 1:1 program and nine without such a program.

Research

When the Supreme Court desegregated schools in 1954, it exposed an achievement gap between African American and White students (Blackford & Khojasteh, 2013). White students continue to outperform African American students and demonstrate an ability to be more college-ready after graduation. Educational and political leaders have attempted to reduce this achievement gap for decades. The Bush administration tried to increase student achievement for all students through the introduction of No Child Left Behind (NCLB) in 2001 (Ametepee et al., 2014). The Obama administration attempted to motivate states to address the problem with Race to the Top in 2009 (Howell, 2015). Despite these policies, the achievement gap persists in the United States. Texas is no exception as 62.7% of White students were able to demonstrate college readiness compared to only 38.41% of African American students (Barnes & Slate, 2014).

As technological advancements continue to change the world and the way people interact, computers are being looked to as a tool for increasing academic achievement for all learners. Technology integration is such an important part of education that many schools, districts, and countries have endured great cost to ensure every student has a computer, laptop, or tablet assigned to them. These 1:1 initiatives have become popular all over the world. Countries such as Uruguay and Portugal have already endured the great cost to provide a laptop for every student (Valiente, 2010). Many schools within the United States have followed with 1:1 programs of their own.

Research into the effects of these 1:1 technology initiatives has provided mixed results. Studies such as the BWLI and the Texas Immersion Pilot Program found positive impacts on technology skills and student engagement, but failed to establish any significant relationship between student academic success and 1:1 technology implementation (Bebell & Kay, 2010;

TCER, 2009). Other research found a lack of studies on the effects of 1:1 technology on minority groups, such as African American students, and specific subjects (Bebell & O'Dwyer, 2010).

This study contributes to this conversation by demonstrating the effects 1:1 programs had on standardized test scores for African American students enrolled in Algebra I and English I in nine Texas high schools. This study took a quantitative look at the effect on student achievement of providing every student with a wireless Internet-capable device.

Interpretation of Findings

The results of this study showed that 1:1 technology had no positive significant statistical impact on African American student achievement as measured by EOC exams. The study demonstrated a negative statistical impact for 1:1 technology in Algebra I while also demonstrating lower mean scores in English I, although not statistically significant. Next, I discuss the findings for each research question.

The first research question was the following: How does participation in a 1:1 technology program affect academic achievement in Algebra I among African American high school students? The results demonstrated a significant negative statistical impact on student academic achievement on the Algebra I EOC exam for students who participated in a 1:1 program. This finding showed a laptop for every student was not beneficial for Algebra I and had a negative impact on student academic success. African American ninth-graders scored higher on the state required Algebra I EOC test if they did not have the additional 1:1 technology throughout the year.

These results suggest that the H_O hypothesis should be rejected and, for the H_A hypothesis, it should be accepted that significant mean differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based on the EOC Algebra I exam. The importance of this is that the participation in a 1:1

program indicated a negative impact on African American students' achievement on the Algebra I EOC.

The second research question was the following: How does participation in a 1:1 technology program affect academic achievement in English I among African American high school students? The results from an independent *t* test demonstrated there was not a significant statistical impact on student academic achievement on the English I EOC exam for students who participated in a 1:1 program. This finding showed a laptop for every student did not raise academic achievement, but it did not have the negative effect it did on achievement in Algebra I.

These results suggest the H_O hypothesis should be accepted because no significant differences exist between ninth-grade African American students who participate in a 1:1 technology program and those who do not based upon the EOC English I exam scores. For the purposes of this study, the importance of this finding is that 1:1 technology did not improve student achievement in English I.

This study presents evidence that the investment in a 1:1 technology program may not be worth the resources required, especially if the desired outcome is an increase in standardized test scores. These findings demonstrate technology saturation within the classroom does not increase student academic success on standardized tests. This is important because schools and districts are judged based on how their students perform on state-mandated standardized tests. In Texas, the State of Texas Assessment of Academic Readiness (STAAR) is used to measure students' academic success and student academic growth from one year to another. Texas holds districts and schools across the state accountable for these results. Schools that perform below the expectations receive a grade of "F" and have to create and implement school improvement plans (TEA, 2017-2018). This should give educators pause before investing the large amounts of money into technology in hopes of improving academic achievement for all students.

These results are limited in their ability to be generalized across education. There are several factors that cannot be accounted for within this quantitative study: (a) the amount of professional development teachers received before incorporating such technology into lesson design was not measured, (b) how often technology was used during lessons was not documented, and (c) how the students chose to use the technology during class or at home was not monitored. The use of a mixed methods approach in future studies could address such questions.

This study could be replicated as a quantitative study or with a mixed methods approach. Replicating this quantitative study in other districts in the state of Texas or even in other states would be beneficial to the validity of findings. In addition, a mixed methods approach could include teacher and student interviews to account for questions about professional development or amount of technology implementation. The 1:1 schools were in the same area within the state of Texas. Replicating this same study in other states may yield different results.

Limitations

The limitations of this study include campus environment or culture, type of technology used, and the degree technology was integrated into lessons. Although all students take the same standardized test and are taught the same Texas Essential Knowledge and Skills (TEKS), they do not all have the same teachers, campus, or even district.

Each campus has its own culture and creates an environment unique to its campus. To minimize the effect this limitation might have on the study, I chose a large sample size. The sample size included 18 schools with 7,283 individual scores. This included nine schools with a 1:1 program and nine schools without such a program. I chose all 1:1 schools from within the same school district, while I chose schools without a 1:1 program from campus comparison groups. This helped to ensure similar campus demographics and socioeconomic levels.

The type of technology assigned to students, and the level to which technology was integrated into lessons was another limitation of the study. To minimize these limitations, I chose high schools for this study because they assigned every student a laptop to use at school and home. Different forms of technology, such as tablets, may have affected the results of this study. Therefore, this study was limited to one form of technology—laptops.

Additionally, the amount of professional development provided to teachers and to what degree they integrated the technology into their classrooms created additional limitations. I was not able to minimize or determine the effects professional development played in 1:1 classroom instruction. Further mixed methods studies may be able to address this limitation.

Several previous studies have shown positive impacts of 1:1 technology on student performance in mathematics, reading comprehension, and reading fluency as well as increases in overall student engagement (Drijvers, 2013; Hallstedt et al., 2018; Hull & Duch, 2019; Kaman & Ertem, 2018; Roschelle et al., 2016). This study demonstrated potential negative effects of such a saturation of technology within the classroom, especially in the area of mathematics. It is important to note that one potential reason for such contradictory results to previous research is the use of nonrandom sampling. I selected the nine 1:1 high schools because of their participation in a 1:1 initiative and demographic similarities. All 1:1 high schools came from the same large school district within the state of Texas. This nonrandom selection method may have contributed to results which contradict some previous research.

Recommendations for Future Research

The following are recommendations for practical applications of this study's findings and possible future research. These findings demonstrated that technology saturation in the classroom may not increase student academic success for African American students on standardized tests.

This study does not provide any evidence the achievement gap between White and African American students was improved by technology saturation within the classroom. Therefore, it is not recommended that large amounts of district resources be dedicated to a 1:1 level of technology in the classroom if closing the achievement gap is the motivating factor. Schools across Texas and the nation are measured by how their students do on standardized tests. If the goal of educational leaders is to improve performance on these high-stakes tests, then investment in a computer for every student is not the answer.

The results of this study do not address other potential effects of technology that may be researched in future studies. As identified in Chapter 2, there are other benefits to technology in the classroom such as greater student motivation (Elliot-Dorans, 2018), a more interactive environment (Rueda et al., 2017), and increased student attention during class (Cetin & Cetin, 2018). Technology is not leaving the classroom anytime soon and future research should focus on the types of professional development most beneficial in turning technology from a hindrance to student achievement on a standardized test to a tool for increasing learning for all students.

Recommendations for District Leadership

As new technologies continue to emerge, communities are demanding higher levels of technology usage in the classroom. This places pressure on school boards and educational leaders to devote large amounts of district resources to keep up with what other schools and districts may be doing in the area of technology integration. Educational leaders need to be able to use research to make informed decisions about such district resources. This study adds to the conversation with data which do not support providing every student with a wireless device and recommends exploring other options. I do not recommend removing technology from schools, however, it is important to understand technology saturation could have a negative impact on standardized test scores, especially in the area of mathematics.

Conclusion

The achievement gap between African American and White students continues to exist in Texas and the United States. This study demonstrated that technology may not be the answer to closing this achievement gap. Although there may be many other benefits to 1:1 technology programs, increased scores on state and federally mandated standardized tests may not be one of those benefits according to the results of this study. The push for technology is not going to go away, therefore, educational leaders need to know the potential positive and negative impact that comes with a push for more technology.

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Appendix A: IRB Approval

ACU IRB # ____ ____

SIGNATURE AND ASSURANCE FORM

****FORM MUST BE READ AND SIGNED BY THE STUDENT INVESTIGATOR AND THE FACULTY MENTOR. THE RESPONSIBILITIES OUTLINED BELOW MUST BE ACCEPTED BY THE STUDENT INVESTIGATOR AND THE FACULTY MENTOR**

Title of Project: The Effects of 1:1 Technology on African American Students' Achievement in Algebra and English

Date of Request: **3/6/2020 [must match the date of the application/review submitted]**

Review being requested:	Type of Review being requested:
☐ New Study ☐ Amendment ☐ Continuing Review ☐ Unanticipated Problem/Noncompliance ☒ Inactivation ☐ Other: ____________	☒ Exempt ☐ Exempt Limited Review ☐ Expedited ☐ Full Board

PRINCIPAL INVESTIGATOR'S ASSURANCE

By signing this form, the investigator assures that [check all]:

☒ The Investigator understands ACU's and the IRB's policies on human research and will oversee the research to ensure that it is conducted in accordance with these policies and with the federal regulations (45 CFR 46 and CFR Title 21)

☒ The Investigator will supervise all study personnel and ensure that they are adequately trained on all study procedures

☒ The Investigator will protect the rights and welfare of the study participants, ensuring that the study is conducted in accordance with the IRB approved protocol

☒ The Investigator will ensure that all participants give informed consent, and that this consent is documented, unless a waiver or alteration is approved by the IRB

☒ The Investigator or research team will not make any changes to a non-exempt study protocol without prior approval by the IRB unless necessary for the immediate welfare of the participant

☒ The Investigator will report to the IRB promptly, according to the policies and procedures set forth by the University and the IRB, any unanticipated problems or events of noncompliance

☒ The Investigator will report to the IRB and to the participants any new information that may change the participants' willingness to participate in the study

ACU IRB # : ________

☒ For studies requiring full board review and any other study deemed to require continuing review, the Investigator will submit a continuing review at least 30 days prior to the study's expiration date. Otherwise, the Investigator will halt all research activity should study approval lapse until the extension is granted or unless it is determined by the IRB that it is in the best interest of the active participants to continue participation during the lapsed time.

☒ The Investigator will submit an inactivation request at the end of the study or if the study is being discontinued.

☒ The Investigator will maintain study data and records for the required time, in accordance with the University, the law and/or the funding agency, whichever is longest, but at minimum 3 years after completion of the study.

Principal Investigator Signature — Date: 11/25/19

Chad Wolf Chad Wolf
Principal Investigator Printed Name

The faculty mentor is responsible for the supervision and assurance of compliance for this project. The faculty mentor should review protocols as often as needed to ensure that the project is being conducted in compliance with our institutional policies and any respective regulations.

By signing below the faculty mentor agrees to monitor the project and ensure the student is meeting the above responsibilities. The faculty mentor agrees to maintain study records, in paper or electronic form, on ACU campus for the minimum required time as outlined above.

Faculty Mentor Signature — Date: 11/25/2019

__John Kellmayer_ John Kellmayer
Faculty Mentor Printed Name