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The Relationship Between Student Participation in a 1:1 Laptop Initiative and Academic Achievement in a 9-12 Upper Middle Class Suburban New Jersey Public School District

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Upper Middle Class Suburban New Jersey Public School District

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Abstract

The use of laptop computers in 1:1 settings is becoming increasingly prevalent in America's schools. As greater numbers of students are using this technology, establishing its benefits and costs is paramount, especially in light of so many demanding fiscal situations. This study used quantitative research and analysis to measure the benefits and costs of such an expansive distribution of technology. It seek*s* to answer the question of the worth of such a large-scale adoption.

This study explored the relationship between the use of a laptop computer on a 1:1 basis for the purpose of academic instruction and its connection to the academic achievement of students in upper middle class suburban New Jersey high schools. This study used propensity score matching (PSM) primarily via ANCOVA to determine if significant differences existed in student performance while controlling for student demographic and academic characteristics. The data for this study were collected from two demographically similar high schools with the only difference being the presence of a 1:1 laptop initiative. The study required specific student demographic data. The independent variables used were gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8). The dependent variable was the use of a 1:1 laptop program for the purpose of academic instruction. The results indicated that the use of a 1:1 laptop program did not have a statistically significant impact on student performance as measured by HSPA Language Arts Performance, PSAT performance, and student attendance. Furthermore, the results indicated that a 1:1 laptop program had a statistically significant relationship with student performance on the HSPA Math test and student grade point average.

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To the friends and family who have been interwoven into my life over these past years, from the Christian Brothers of Manhattan College and St. Raymond's High School for Boys, who showed me countless examples of kindness, caring for children, and the importance of education, to the dedicated and caring public educators that I have the honor of calling colleagues, I can ask for no finer people with whom to spend my professional life. Finally, thank you also to the men and women of the Marble Hill/Kingsbridge section of the

Bronx, who many years ago taught nineteen-year old me the importance of friendship, love, and fellowship. I am forever grateful to them, and it is from their caring that all this springs.

Dedication

This research study, and the work that went into completing it, is dedicated to my family.

Thank you to my wife, Kathie, and my children Jimmy, Meg, and Jack. I could not have asked for a more supportive, caring, and downright fun family. Their support of my time away at Seton Hall, all without complaint, made the work and attention necessary to succeed all the more possible. Words fail when trying to capture the love and gratitude that I have for them.

Thank you to my parents, James and Patricia Gatens. All that I am today came from them, and their unconditional love (and copious amounts of patience) for me set a powerful example of what a parent should be. It is bittersweet that my father could not be here to read this dedication; but God had different plans, and I look back with fondness on the years that we had together. My father loved me without condition and while he would take great pride in this accomplishment, his love for me would not grow or diminish as a result. His love was never dependent on what I did or did not do but was rooted in my simply being his son. As a result, my parents' boundless love for me is matched only by my love for them and, in turn, for my children.

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CHAPTER I

INTRODUCTION

Background

For as long as there have been schools, some form of technology has been used to augment the student classroom experience. From the introduction of chalkboards to the studies conducted by various researchers, school systems have continually turned to the latest technology to improve student performance (Saettler, 1990). The federal government, via the National Center for Educational Statistics, discussed the expansion and breadth of this technology in their report, *Teacher Use of Educational Technology in U.S. Public Schools: 2009*, observing that 97% of all teachers had one or more computers in their classrooms every day and that internet access was available for 93% of the available computers. Further, the ratio of students to computers in the classroom was 5.3 to 1. The report further indicated that not only were computers available in the classroom but that 40% of instructional time included the use of those computers (NCES, 2009). The idea that computer-based instruction is beneficial to student learning has been revealed in the practice of teachers, as well as the tools made available to students.

The continual integration and, some would say, saturation of technology into the day-to-day lives of American students continues to grow as schools adopt 1:1 laptop initiatives. In 2013, Pearson, Inc., working with Harris Polling, commissioned a study which offered perspective on the breadth of technology adoption by students. In middle school, 70% of students reported using laptops for learning, and in high school that number jumped to 75% (Harris Interactive, 2013). Further, it was posited that student use consisted of a variety of school-related activities, including conducting research, doing homework, and checking assignments. Students also indicated that they want to use full-size laptops for completing these tasks and that current technology, while sufficient, could be augmented with larger offerings and greater ease of use.

Recognizing the widespread use of computers and their increased integration into the lives of students, schools have responded by moving more and more towards 1:1 laptop initiatives. Students are supplied with personal computing devices to be used both in the classroom and as part of their overall academic experience. As noted by Penuel (2006), schools and governments continue to establish and offer 1:1 computing programs in an effort to transform student learning, enhance future job prospects, offer equity opportunities, and improve student academic achievement.

The International Society for Technology in Education (ISTE), a leader in the field of educational technology, has developed and published standards that speak to the wide variety of expectations for students, teachers, and administrators. Among the areas addressed are the modeling of digital-age learning, developing model instructional strategies and curriculum, and promoting digital citizenship (ISTE, 2017). These standards are comprehensive, wide-ranging and designed to offer all consumers of digital learning experiences a guide to how to include technology in the classroom. Yet, although ISTE has broadly shared the various standards for students, teachers, and administrators (among others), there is still a lack of clear consensus regarding the long-term benefit or efficacy of instituting a comprehensive 1:1 student laptop program. As noted by Dunleavy and Heinecke (2008), there is a lack of rigorous studies that put special emphasis on the need for additional well-developed research that will measure the impact of 1:1 learning on student achievement. They further noted that the use of laptops in a 1:1 setting has been shown to increase student interest and engagement, but no studies have shown the connection between laptop use and student achievement. Schools, when making decisions regarding laptop procurement and distribution, would benefit from research that illuminates the connection between that technology usage and student achievement.

Statement of the Problem

One of the major goals of the introduction of technology into the school environment is to foster and promote increased student achievement. For many school districts, the issuing of 1:1 laptop computers for the purpose of student individual usage has become a common phenomenon as the technology has become more cost-effective, and the use of Learning Management Systems (LMS) to organize student learning has risen in prominence. As noted by Carl Straumshein (2013), a report by MarketsAndMarkets stated that the global market share for LMS systems will rise from 4.07 billion in 2015 to 11.34 billion by 2020. The expansion of LMS systems has been aided by the strong growth of Chromebook laptop devices. Chromebook purchases accounted for 78% of all laptop shipments to U.S. elementary, middle, and high schools for a portion of 2015. This was a significant bump up from the 42% a year earlier (Leswin, 2014). It is clear from this expansion that school districts have made significant provisions for the use of this technology.

All of these purchases and the dedication of time and resources lead one to wonder: What is the impact on student achievement of layering all this technology onto the student learning experience? School districts have prioritized the purchase of billions of dollars of equipment, resources, and teacher training; but a research gap still exists regarding the type of effect, if any, all this has on academic achievement.

The data are clear. Schools are increasingly relying on 1:1 laptop initiatives to augment classroom learning and assess performance. Knowing the impact those initiatives have on student achievement would allow educators, administrators, researchers, and policy makers to identify both the opportunities they provide and the liabilities they may incur.

Purpose of the Study

The purpose of this quantitative, quasi-experimental, comparative design was to explore how much variance, if any, the implementation of a 1:1 laptop initiative has on student achievement. This study sought to determine the effect, if one exists, on student achievement that can be attributed to the widespread and comprehensive use of a 1:1 student laptop initiative at a suburban New Jersey high school. The results can be used by educators, school administrators, and policy makers to guide decisions regarding future 1:1 student laptop initiatives.

School district adoption of student-based technology that increases the use of 1:1 laptop technology is on the rise. However, there has been considerable disagreement among researchers who have explored the connection between these devices and student achievement. While 1:1 laptop usage regarding student performance as it relates to engagement and motivation has shown a positive increase, there have been inconsistent findings when student performance is considered. Some studies found that student performance is positively impacted (Gulek & Demirtas, 2005; Penuel, 2006), and yet there are others that found a negative impact (Inal, Kelleci, & Canbulat, 2012; Penuel, 2006). Even though schools and states are supportive of the distribution of laptops as key learning devices, it was noted that, overwhelmingly, studies are conducted in the K-8 content areas. This limited research is a barrier to a deeper understanding for school districts when it comes to the dedication of limited time-based and fiscal resources for the implementation of 1:1 laptop initiatives. The purpose of this study was to gain a better understanding of the connection between the extensive use of laptops in a student 1:1 initiative and student academic achievement.

Conceptual Framework

The conceptual framework of this study is that the use of technology in the typical classroom has an effect on the academic achievement of the students (Penuel, 2006; Dunleavy & Heinecke, 2008; Saettler, 1990). Data from this research will enhance the effectiveness and lead to a better understanding of a 1:1 laptop initiative on the teaching-learning culture of a school. As part of the framework of this study, the theory and research of Yong Zhao (2012) underscores the move towards 1:1 laptop initiatives in schools, as he maintains a firm belief that schools should embrace the creativity, talent, diversity, and global and digital competencies that make American children successful and act as a catalyst for their continued success. That effort will be supported by the educational entrepreneurship available through increased access to technology. Zhao (2012) stated the following in his book *World Class Learners*, which explored a number of strategies whereby American schools can continue to remain vibrant places of learning:

> Technology holds amazing potential to support the new paradigm of education in a number of ways. First, as a tool for creation, digital technology makes it much easier and less expensive to create media products, books, arts, and all sorts of other products and services. Second, as a tool of communication, technology enlarges the campus to make it possible for students to learn with experts and resources from outside the school. Third, as a platform for marketing, technology makes it possible for students to reach a global audience for their products. Finally, as a tool for collaboration, technology enables students to work with partners from around the world anytime from anywhere. (p. 43)

School districts, along with policy makers and other non-district educators, continue to search for ways to augment the student learning experience. As noted by Penuel (2006), the use of technology in the classroom has an effect on student learning, and the purpose of this study is to expand understanding of the breadth of that effect. A 1:1 student laptop initiative is driven by the belief, supported by research, that the use of technology in the classroom impacts student learning; and it is necessary to gain a deeper understanding of the potential that such initiatives hold.

Research Questions

The design of this study used a quantitative research method comprised of analyzing standardized test scores from two comparable districts. Demographically and geographically similar, the districts diverge regarding instituting a 1:1 laptop initiative. One has used laptops for the past decade, while the other has technology use, but not approaching the extensive utilization that a 1:1 laptop initiative offers. The collected and analyzed data answered the following questions:

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores, i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores, when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypotheses

Null Hypothesis 1: There is no significant impact on a student’s HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 4: There is no significant impact on a student's HS GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

Study Design and Methodology

Design, Method, and Sampling

This study represents a quasi-experimental, cross-sectional, correlation/explanatory design, utilizing data collected during one period of time—the 2013-2014 academic school year. For the purposes of this study, the researcher utilized propensity score matching (PSM), as it is a statistical matching technique that estimates the effect of an intervention, treatment, or policy. It attempts to account for various covariates that predict receiving the treatment. Bias is reduced by recognizing confounding variables that are found in the measure of the treatment effect established by comparing outcomes among items that were subject to the variable versus those that were not.

The sample for this study consisted of two high school districts that were essentially identical with the exception of two having an active 1:1 laptop initiative while the third did not. These high schools are demographically, culturally, and geographically similar, as they are all ‘I’ districts per the NJDOE’s District Factor Grouping rankings, serve a similar student population and are located in close geographic proximity.

Independent/Predictor Variables

The unit of analysis for this study was at the student level. Consequently, variables in the analysis that were controlled and included in the propensity score matching (PSM) sampling included individual student attendance, gender, free/reduced lunch participation, grade point average, ethnicity, days absent, special education classification, and English Language Learner status.

Dependent/Outcome Variables

The NJHSPA and NJASK are "high-stakes" tests administered to New Jersey students The NJHSPA is administered to 11th grade students and serves as a graduation requirement. The NJASK is administered to 8th grade students and, while not a graduation requirement, does serves as a component in student placement in many schools. Both tests are comprised of two sections—Mathematics and Language Arts. Each section of the test is scored separately, with scores ranging from 100-300 (NJDOE, 2004). The NJDOE sorts students into one of three categories based on their scores: Partially Proficient (100-199), Proficient

(200-259), and Advanced Proficient (260-300). Students must obtain a minimum score of 200 on each section in order to pass (NJDOE, 2004).

The Preliminary Scholastic Aptitude Test (PSAT) is a standardized test administered by the privately owned College Board. Each year 3.5 million students take the test, which is used as a practice test in advance of the Scholastic Aptitude Test (SAT) and serves as a qualifying test to establish eligibility and qualifications for the National Merit Scholarship Program (College Board, 2015). Student total PSAT score is ranked from a low of 60, representing the 1st percentile, to a high of 240, representing the 99th percentile. This individual score is a sum of the critical reading, mathematics, and writing skills scores.

Significance of the Study

There is limited research regarding the impact of 1:1 student laptop initiatives on student achievement. This study was conducted to help us better understand the effect, if any, of these initiatives, and the benefit that they may provide to student achievement.

The findings of the study will (a) add to the existing but currently limited body of literature on the topic of 1:1 laptop initiatives and their impact on student achievement; (b) aid school districts and district leaders in developing responsible and relevant 1:1 student laptop programs; (c) assist local, regional, national, and international governing bodies that set educational technology standards to evaluate the effectiveness of 1:1 student laptop programs; and (d) aid superintendents in identifying and sharing the relevant research and analysis necessary to guide districtwide 1:1 student laptop programs.

Limitations of the Study

There are several limitations to this study. Due to the restrictions of standardized testing and the breadth of its use, there are limited cross-school data that can be analyzed. The collected data also may be affected by a broad range of factors, or lack thereof, that fall outside the scope of the 1:1 laptop initiative. The schools are similar in size, demographics, and socioeconomic status; and the results of the study may not be transferable to schools and districts that fall outside these parameters. As to the school without the 1:1 laptop initiative, it still has robust technology usage, and it is not as if the technology usage consists of an either/or situation.

Delimitations of the Study

The study is delimited to students in 11th grade who attend two demographically similar high schools. The high schools studied are in northern New Jersey suburban districts that are seen as being "bedroom communities" for New York City. Both schools share the same District Factor Group (DFG) as assigned by the New Jersey Department of Education. Based on socioeconomic factors including, but not limited to, adult educational attainment, occupational status, and median family income, each school district is ranked from "A" (poorest) to "J" (wealthiest). Both districts are considered to be "I" districts.

Assumptions

This study is predicated on several assumptions: (a) that the use of 1:1 laptops is so extensive in the one school district that it has significantly altered the student experience, leading to an effect on student achievement; (b) that the non 1:1 laptop district has not created a "de facto" 1:1 environment by copious technology usage; in other words, they are a 1:1 district in all things but name; and (c) that the standardized test and student performance data are sufficiently rich and robust to provide an accurate and valid analysis of the impact of a 1:1 laptop initiative on student achievement.

Definition of Terms

1:1 Computing: A school- and home-based situation in which a student has individual and sole access to an Internet-connected computer. Policies may differ on whether students are allowed to take the devices home (Penuel, 2006).

Standardized Test: Any form of test that (a) requires all test takers to answer the same questions, or a selection of questions from a common bank of questions, in the same way, and that (b) is scored in a "standard" or consistent manner, which makes it possible to compare the relative performance of individual students or groups of students.

Technology Leadership: A situation in which a staff member acts as a key facilitator and coordinator of district, school, and classroom-level implementation, integration, and usage of technology (Morsund, 1985).

Technology Integration: The consistent focus on and inclusion of diverse technology into the daily operations at district, school, and classroom levels by individuals who are not fearful of trying out new varieties of technology on a consistent, strategic, and systematic basis.

Technology Usage: The active and ongoing engagement and use of technology for professional, personal, and/or technical skill development, accessing information, networking, solving problems, critically thinking, communicating, and performing various tasks.

Organization of the Study

This quantitative research is organized into five chapters. Chapter I of the study provides background information about the problem, the purpose of the study, the conceptual framework for the research, research questions, the significance of the study, limitations, delimitations, assumptions, and definition of terms used in the study. Chapter II focuses on relevant literature about the implementation and use of 1:1 laptop programs by students and their connection to student achievement. This chapter also offers relevant background and history for the use of laptops in a 1:1 setting, including the overall use of technology in the teaching-learning environment. Chapter III explains the data collection methods, the selection process used for the participant school districts, the rationale for the use of the selected data, research questions, population of the study, sample specification, instrumentation used, the data collection, and the methods of data analysis. Chapter IV offers an analysis of the data and interpretation of the findings and results, while Chapter V elaborates on that analysis and also includes a summary, conclusions, implications for policy and practice, and recommendations for future research.

CHAPTER II

REVIEW OF THE LITERATURE

This study examined the academic impact of a one-to-one (1:1) laptop initiative on a suburban New Jersey 9-12 high school. Specifically, it studied that impact as it relates to student performance on state-required standardized test scores in both Math and Language Arts Literacy (LAL). The results of this study attempted to provide the amount of explained variance in student academic achievement in a suburban New Jersey 9-12 high school, both with and without one-to-one (1:1) student laptops. The objective of this study was to expand on current research and analyze the findings to give school leaders and policy makers recommendations for policy and practice.

Literature Research Procedures

This literature review serves the dual purpose of offering the necessary background for the topic of the research study and laying the foundation that served as its inspiration. It is essential that the author of any study provide interested readers with a full understanding of the topic at hand and the research that has been done previously in order to establish the research base from which the study takes its inspiration. It was the desire of this researcher not only to review the relevant literature but also to offer a base understanding of the existing research to explain the growing phenomenon of 1:1 laptop usage in the classroom. As the literature review shows, the use of laptops as core components of a student's classroom experience is continuing to grow (Inal, Kelleci, & Canbulat, 2012), and understanding this growth is essential for the creation of effective policy and adjustments in practice. A broad variety of literature, including government reports, dissertations, peer-reviewed research, and seminal works, are all included in this review. Additionally, variables identified as control variables in the sampling methodology, noted in the literature as being significant contributors that influence student achievement, are also briefly discussed. Electronic resources used included ERIC, EBSCO Host, ProQuest, and Seton Hall Dissertations and Theses. Search parameters went beyond basic queries and instead used advanced wording and language to capture a broad range of publications encapsulating the research base related to 1:1 laptop usage. Web-based research also included New Jersey Department of Education (NJDOE) websites and data, ed.gov and Google Scholar. A variety of keywords, used individually and in combination, were also part of the research and included, but were not limited to one-to-one, laptop, academic achievement, NJASK, NJHSPA, limited English proficiency, gender, socioeconomic status (SES), suburban schools, laptops and higher education, classroom laptop usage, and grade point average.

This chapter serves to analyze and examine past research on the topic of technology in the classroom and, more specifically, the research base that examines the use of 1:1 laptop computers as part of the teaching-learning process and its impact on student academic achievement. The independent and dependent variables in this study include student performance on the New Jersey Assessment of Skills and Knowledge (NJASK) and the New Jersey High School Proficiency Assessment (NJHSPA), Preliminary SAT (PSAT), gender, free/reduced lunch status, grade point average (GPA), days absent, special education status, and limited English Proficiency (LEP) status.

Organization of the Literature Review

The section on the theoretical framework takes up the use of technology to impact instruction, followed by the historical background and implications of computers in education and research that speaks to the efficacy of 1:1 laptops in the classroom. Next, there is an examination of student variables, including NJASK, NJHSPA, PSAT, free/reduced lunch status, GPA, days absent, special education status, and LEP status. The chapter ends with a conclusion.

Theoretical Framework

The theoretical framework of this study is the connection between the use of technology in the typical classroom and the effect it has on student learning and, therefore, academic achievement (Penuel, 2006; Dunleavy & Heinecke, 2008; Saettler, 1990). Recognizing that schools are adopting 1:1 laptop programs at increasingly higher rates (Zhao, 2008), it is essential that continued research takes place in order to see the impact not only on the teaching and learning environment but also on the overall school setting as it relates to the policy, practice, and future settings.

Recognizing that the use of technology in the classroom has an impact on student learning, one can also approach the use of technology as being supported by the pedagogical concept of constructivism. Establishing a clear philosophical and theoretical foundation for the use of 1:1 laptop technology in the classroom lies in the need for flexible, robust, and effective pedagogy. A theoretical and philosophical foundation provides answers to the how and why of specific pedagogy, including the question of whether the use of laptops should be a part of classroom instruction. One philosophy for informing the use of laptops in the classroom is constructivism (Doolittle, 2003).

The work of Dewey, its relation to constructivism, and its connection to the use of laptops is discussed at length within the following section. This provides a solid foundation from which to better understand the theory and practice that underscores the use of laptop technology and its impact on student academics. Constructivism employs a cultural relativistic, flexible, and contemplative perspective, wherein knowledge is constructed based on personal and social experience. The use of laptops on a 1:1 basis by students becomes intertwined with the entirety of their school experience and intersects nicely with constructivist theory. Fosnot (1996) has expressed the following in regard to constructivist theory:

> Learning from a (constructivist) perspective is viewed as a self-regulatory process of struggling with the concept between existing personal models of the world and discrepant new insights, constructing new representation and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse and debate (p. ix).

As a result, constructivism consists of the creation and modification of thoughts, ideas and understandings as the result of experiences that occur within the socio-cultural context. While there are various sub-categories of constructivism (i.e. radical and cognitive), for the purpose of this literature review, the focus remains on social constructivism. This form of constructivism emphasizes the social nature of knowledge. It holds the worldview that the individual can only make sense of the larger world via social interaction rather than individual experience. (Garrison, 1998). For social constructivists, "the process of personal meaning-making takes a backseat to socially agreed upon ways of carving up reality . . . the community is the prime source of meaning for objects and events in the world" (Prawat, 1996, p. 220). The 1:1 use of laptops in the whole-school setting by individual students meets the criteria of social constructivism as the students use the devices in a wholly social setting for both their academic progress and their continued act of making meaning of the larger word.

Relying on social/activity-based sources of knowledge is a core concept of social constructivism. This, in turn, brings culture, language, and context to the front. (Dewey, 1896; Gergen, 1995; Vygotsky, 1896). Per the work of Dewey and his development of the theory of constructivism, laptop usage fits into this theoretical framework, as it helps to expand the knowledge base of the learner, eschews the presence of a fixed base of knowledge, and instead believes that learning takes place via thinking and communication (Hirtle, 1996). Per the work of Kutz and Roskelly (1991), the practical applications of social constructivism provide continued support to the theoretical framework that supports the use of laptops in the classroom:

- Adding connections to the outside world via Internet access, newspapers, research, and helping to make connections to other classrooms and schools—in essence, bringing the world into the classroom.
- Problematizing situations and concepts—Laptop usage, especially as an extension of the student's school life, helps to create constructivist-based situations which ask students to gather real-life examples and see the value in both the problem and the solution.
- Redefining school literacy so that students begin to construct new literacy skills as they relate to technology and learning.

School districts, along with policy makers and other non-district educators, continue to search for ways in which to augment the student learning experience. As noted by Penuel (2006) and others, the use of technology in the classroom has an effect on student learning, and the purpose of this study was to expand understanding of the breadth of that effect. A 1:1 student laptop initiative is driven by the belief, supported by research, that the use of technology in the classroom impacts student learning, and it is necessary to gain a deeper understanding of the potential that such initiatives hold.

Computers and Education

Employing its formal description, the *Merriam-Webster Dictionary* (2007) defines a computer as "a programmable, usually electronic device, that can store, retrieve, and process data," and it is that simple definition from which the worldwide, culture-shifting and society-altering use of computers has sprung. While non-electronic computers, relying greatly on gears and levers, existed for centuries before the advent of electricity, it was with the availability of a regular power source and the development of microprocessor ability that the electronic computer began to capture and hold information, return that information to the user upon command, and help that information interact and affect other information (Wilkes, 1977). Early pioneers like Charles Babbage and his building of a “difference machine” to make large-scale calculations using gears and levers portended the advancement of computing scale and power that would change the world.

While there were advancements in technology following the end of World War II, it was the launch of the Russian satellite *Sputnik*, the ensuing “space race” with the Soviet Union, and the increased attention on education as a national security issue that drove the eventual nexus between the use of computers in education and the belief that such usage may lead to increased student knowledge and success (Molnar, 1997). This began what was known as the “golden age” of education as increased national attention was paid to education in general and specifically to math and science as necessary subjects in order for the United States to compete on the international stage. Education became a proxy for national strength, and increased proficiency was viewed as a national security issue.

The diffusion of computers into the classroom began at the “top level” of education and filtered downward through the ensuing academic grade levels. Classroom computer usage did not begin at the elementary or even high school level, but rather started with collaboration between the military and universities such as Harvard and the University of Pennsylvania. Legendary computers such as the Mark I and ENIAC developed in massive warehouses and weighing thousands of pounds, were used primarily in the fields of mathematics, science, and engineering as mathematical problem-solving tools. This technology led to the end of the regular use of the mathematical mainstay, the slide rule.

In 1963, Dartmouth researchers John Kemeny and Thomas Kurtz began to transform the use of computers from one of strict academic research to developing the computer's role in the academic experience of university students. Rather than have students wait in long lines to "batch process" punch cards, universities instead set up a sharing schedule that gave students one-to-one time with the massive mainframes that completed thousands of calculations instantaneously. This development evolved into the idea of regional computer centers and the development of user-friendly languages such as BASIC and FORTRAN. The shift away from computers, not just to inform research but also to add to the experience of the student began at this level and began to filter downward into the experience of the classroom student (Molnar, 1997).

In the 1970s, a series of regional computing networks, designed for the purpose of offering access to students, were developed by the National Science Foundation (NSF). These 30 networks were primarily used by schools of higher education and had some penetration into secondary schools. By 1974, over two million students nationwide had access to computers in their classrooms. The speed and size of the growth was impressive. In 1963, only 1% of the nation's secondary schools used computers for classroom instructional purposes; but by 1975, 55% of the schools had some form of computer access, and 23% of them were using computers to assist and inform classroom instruction (Molnar, 1975).

In 1965, Gordon Moore, co-founder of Intel, noted that the capacity and speed of computer chips and microprocessors were doubling every 18 to 24 months. This principle, which became known as Moore's Law, has continued for the past 50 years and has led to the exponential and incredible growth of computing power. As described on the Intel website, “50 Years of Moore’s Law,” the impact of this principle across a wide spectrum of our world is noted for its effect on society, technology, and the economy. Along with those areas, it has also impacted education as computers became more economical and financially feasible in the classroom. Within 15 years of Moore’s prediction, microcomputers had moved from the bulky, power-hungry mainframes held solely in the domain of the university into day-to-day life. Personal computers, non-existent just years earlier, had moved into the office, the home, libraries, and classrooms. The computer, once the domain of the academic researcher, had moved into the domain of general society, and it was only natural for attention to turn to the classroom (Molnar, 1975).

As Scott (1992) noted, the intersection of growing computing capacity with general academic and educational anxiety created a situation in which many people turned to computers as a means of solving a difficult situation. Educational use of computers appeared to offer a technology-based “quick fix”—a relatively cheap, teacher-agnostic, and simple solution—to what is viewed as a long-term, expensive, and dirty problem (Kerr, 1991). Yet, as noted previously by Cuban (1986), the education status quo is resistant to change, quickly absorbs the latest “fix,” and returns to business as usual. Early phases of computer adoption repeated the same cycle as the introduction of radio and film. These two transformational media, as they were having a strong impact on society outside of the schoolhouse, were also heralded as being educationally transformational. Yet, after the initial fanfare that accompanied the technology, classrooms reverted to their traditional teacher-centered instructional strategies.

One cannot offer a review of both the literature and history of technology in the classroom without again referring to Cuban (1986) and the particular resistance of the educational establishment to change. Per his work, one of the consistent factors regarding the introduction of new technology is the ability of the current system to retain the current goals and social organization and hence a desire to meet the old goals with better efficiency. In order to be successful, the "old" environment needs to be fundamentally changed along with the introduction of new goals in order for the technology to take effective root. As this is difficult to do in even the most progressive settings, it reveals the fundamental contradiction between the conservative nature of the educational system and the capacity of each new technology to fundamentally change the interactions inside the classroom. This is especially significant, as any attempts to use computers to effectively change education will meet with resistance; and this offers meager justification for optimism. The work of Cuban (1986) is especially relevant, as the core effect being measured in this study is the impact that intense and consistent computer usage has on the performance of high school students and on their academic experience.

Scott (1992) continued to observe that while Cuban's concerns are noteworthy, this has not prevented computer-based classroom practices from becoming increasingly relevant to the education system. The 1980s served as a transformational time in which the computer moved further away from the perception that it was a machine to be used only for research and computer language programming to a more utilitarian and useful tool for the average user. The advent of personal microcomputers with the ability to use "off-the-shelf" computer programs to add more user-centric and easy-to-use applications in the form of accounting, general information, and game playing moved computers even further into the cultural mainstream. As computers were being used more and more outside the classroom, naturally the expectation that they would become part of the classroom landscape became more the rule rather than the exception.

Examples of the growth in computer usage took the form of word processing and the ability to now partake in the traditional writing skills found via handwriting and typewriters much more quickly and easily, computer games that would offer hours of entertainment for users, and number manipulation via spreadsheets offering quick and efficient calculations. What made this all the more remarkable was that these capabilities did not exist just a few years earlier, and now they were becoming commonplace at all levels of society. Added to this growing ability of computers (and their users) to communicate across connected networks, society was quickly adapting to the new reality of what computers can do. It was only natural for them to make their way into the classroom (Kinzer, Sherwood, & Bransford, 1986; Trainor, 1984).

From this growth, it became apparent that the computer had shifted from a "calculation machine" to a general machine for the purpose of collecting, analyzing, and manipulating information. This in turn made it into a tool for pursuing education goals that had nothing to do with computer programming; rather, it was viewed as an item to be used by the student to increase educational capacity. These educational goals were further strengthened and supported by the explosive growth of the Internet as not only a school-based but a society-wide phenomenon. Internet usage, both in the United States and worldwide, enjoyed what is often described as "hockey stick" growth from 1990 to 2010. Per the World Bank (2015), worldwide Internet usage grew from 0.254% of the population to 43.998% during that time. The Internet had clearly taken a hold on the attention of the world, and unsurprisingly that filtered into the classroom setting. From this belief, Scott (1992) reported that it was established that students should be able to use computers for the following education activities:

- Drill and Practice—The use of computer-assisted instruction (CAI) made this traditional learning activity easier to deliver. Rather than dedicate time and effort to drilling individually with students, teachers can now use a variety of commercial programs to reinforce this low-cognitive activity, but can do so with more speed and efficiency (Suppes, Smith, & Beard, 1977). While the ability to use a computer in this manner adds to the efficiency of offering drill and practice activities, it would be an error to think that speeding up these activities or offering them more easily would have a long-term positive impact on the academic growth and potential of the students.
- Integration of Learning Systems—Prior to the use of computers, teachers often had to separate the disparate expectations of their subjects, i.e., writing during one part of the day and a different part of the day for math instruction. Computer usage and commercial programs created the opportunity for teachers to merge a variety of activities into single class units. The integration of hardware and software created learner experiences that were woven into single activities. Along with this merging of activities, the programs offered instant feedback on the performance of the student, and the need for assessment feedback to be delayed no longer existed (Kelman, 1990). A downside of this integrated approach was that vendors primarily targeted lower socioeconomic student groups and advertised these programs as being effective solutions to these

challenges but with little research-based support. Instead of being helpful to these students, they instead fell into the trap, as noted by Cuban (1986), of being absorbed into the academic mainstream and therefore rendered ineffective. Kelman (1990) continued to note that while test scores seemed to rise under this model, the research to show sustained and consistent growth was wanting, and that it should be avoided on both pedagogical and philosophical grounds.

- Instructional Gaming—The use of computers to create a game-based learning environment has been one of the more popular uses of the computer in the classroom. As noted by Levin and Souviney (1983), taking traditional games and using the graphics, sound, and interactive nature of the computer enables a higher interest level on behalf of the child and therefore increases the amount of time in which students want to engage in the learning activity. With the increase in computer power and the exponential growth of the computer education industry, the use of computers in the classroom has not slowed but continues to be not only a multibillion dollar industry but also a mainstay in both the personal and educational life of students (Huotari & Hamari, 2012).
- Word Processing—Most of the work through the use of classroom computer usage has centered on the language arts and, more noticeably, support for student writing skills. This serves not only as a guide to writing with greater proficiency but also to generate higher interest in literature in general (Daiute, 1985). With the advent of the Internet-dependent Chromebook and easy access to online writing tools such as Google Docs, the ability to author, edit, and share has become a core

competency in many classrooms. As per Victor D. Alhadeff's 2016 article in *eLearning Magazine*, Google user adoption of the entire suite of Google applications is expected to reach 110 million by 2020. This is a conservative estimate and greater adoption would not be surprising based on a 40% year-after-year growth for the next five years. This is in accordance with the technology-minded growth found in Moore's Law and indicates the widespread cultural adoption of the computer as a ubiquitous student companion both at school and at home.

From the widespread growth and use of computers in the classroom, the requisite change in teaching practice and the (sometimes halting) progress that has come from its impact on the cultural mainstream, it has been established that there are positive impacts on the student classroom experience, especially as it pertains to students' subject area interest and classroom participation. Baker, Gearhart, and Herman (1989) noted several positive outgrowths of computer usage. The locus of control for classroom work shifted from the teacher to the student, and the student approached the classroom work with greater responsibility. Fluency in writing speed and writing quality increased as a result of the use of computer-based word processing. Specifically, students experienced an increase in comprehension, vocabulary, and sentence structure. Core skills were gained more quickly, and teachers were able to move on to more complex and deeper tasks due to the speed with which computer usage added to student skills.

The integration of computers into the classroom, from their earliest iterations as boxy, complex, and room-sized machines to their current usage as laptop "magic boxes," has had a profound impact on our schools. As noted by many researchers, educators continue to turn to computers as a positive tool in the classroom; but as this study shows, there is still a need to measure and assess the overall impact of laptop computers. This is especially relevant, as computers are now being issued on an individual student basis and taking greater prominence in the academic and social lives of our students. This relationship, growing over time, must be evaluated for its promise and its pitfalls.

The Development of 1:1 Technology in the Classroom

For as long as there have been students, teachers, and classrooms, there has been the relentless onward march of attempting to use technology to improve the educational experience of the student. Whether it be the use of slate boards to write down answers, the installation of blackboards and the use of chalk to review materials, the projecting of audio and video via film, or the offering of a laptop to each child, schools have continually moved forward in this area (Saettler, 1990). Yet much of the adoption of technology took place before the efficiency and efficacy of this technology were shown to be educationally relevant in the classroom (Christmann, Lucking, & Badgett, 1977).

School systems are legacy institutions and built around traditional practices such as age-grading, curricular sequencing, and standard funding models. It is from this base that schools are attempting to move away from their industrial-era formation and adapt to the new learning options offered by computers, especially one-to-one (1:1) laptop usage and the new individual learner-directed options that they offer (Collins & Halverson, 2010). This third era of education, coined by Collins and Halverson as the “lifelong learning era,” emphasizes customizing the educational experience to the learner’s abilities, needs, and interests. This third era was preceded by the apprenticeship era and the universal-schooling era. Whether it be the individual learning of a trade passed from a master to an apprentice or attendance at a school in a set location with a set curriculum and expectations, the learner was expected to conform to his or her current setting.

Over the last several decades, the ratio of student to computer has steadily fallen. In 2001, the United States had a 5.4 to 1 student/computer ratio, which had dropped precipitously in the last three years from 12.1 to 1. A variety of factors combined to increase student/computer ratio, including the increased use of computers in general society, the educational expectation that computers would lead to increased student interest and academic growth, and a desire for districts to continue to show their public that growth and innovation were present in the district (Internet Access in U.S. Public Schools and Classrooms: 1994 - 2001, 2002). In 2002, the ratio of computers to students more than doubled, and by 2008 the number had begun to draw close to 1:1, with 3.1 computers for each student. The slow march of progress indicated that schools were moving towards 1:1 computers for each student. Along with the computer-to-student ratio dropping, the increase in laptop carts to a 58% adoption rate signals the move towards a 1:1 laptop to student ratio (Warschauer, Arada, & Zheng, 2010). Schools began to install wireless networks (for easy and fast access to the Internet), and computer technology began to be packaged in smaller and smaller computers. Along with the decrease in size and the increase in technological capacity, the cost of computers began to drop and has recently been accelerated by the introduction of Internet laptops that serve only to connect learners to web-based applications and programs. The following is noted in Shah's 2016 *PC World* article, "Chromebooks are siphoning market share from Windows PCs":

> Shipments of PCs with Google's Chrome OS are growing at the expense of Windows laptops and desktops, as the PC market suffers through its biggest slump since 2008. Especially popular are Chromebooks, which are basic Chrome OS laptops for Web computing. Low-price Chromebooks are attractive to students, educational institutions and budget buyers. Worldwide Chrome PC shipments in 2015 are expected to surpass

> those in 2014, according to IDC. Chrome PCs accounted for 2.8 percent of all PCs shipped worldwide through the first three quarters in 2015. For all of 2014, Chrome PCs accounted for 1.9 percent of all PCs shipped. (par. 3)

Clearly, the ability of the inexpensive Chromebooks to work effectively with the near-ubiquitous Internet connections found in schools, along with easy-to-use student learning platforms, has caused a tremendous increase in the ability of schools to offer these once hard-to-finance devices to students.

One-to-one (1:1) computing is centered on the idea that the student and teacher have Internet-connected, wireless computing devices in the classroom and optimally at home as well. An alternate name for this type of learning is "ubiquitous computing," and this assumes that every teacher and student has his or her own computing device and eliminates the need for computer-based learning to occur only in dedicated computer laboratories. William Penuel, Senior Researcher at SRI's Center for Technology in Learning, further ascribed the following characteristics to one-to-one computing efforts:

- Providing students with use of portable laptop computers loaded with contemporary productivity software (e.g., word processing tools, spreadsheet tools, etc.)
- Enabling students to access the Internet through schools/wireless networks
- A focus on using laptops to help complete academic tasks such as homework assignments, tests, and presentations (The Abell Foundation, 2008)

The growth in the individualized nature of technology is no more apparent than in the individual learner using a 1:1 laptop. This interaction personifies, through its quick and fast connection to the Internet, the support of various student learning systems to facilitate learning, and the ability to personalize the student experience increases the potential offered by the technology. It is this appeal, as well as the lower cost, that has enticed so many schools to undertake 1:1 laptop initiatives. That being understood, the research varies on the quality of the student experience when interacting with technology. Acknowledging that schools are particularly resistant to change, a wide swath of traditional practices are considered ripe for alteration, including, but not limited to, the ability to customize the learning experience for the student (a claim often made when instituting a 1:1 laptop program), the teacher as "facilitator of learning" as opposed to a subject-matter expert, memorized knowledge as opposed to knowledge at one's disposal, and recognizing that technology can facilitate learning by doing as opposed to learning by absorption.

Many states have attempted statewide 1:1 laptop initiatives, with as many as 33 states having some form of statewide adoption (Kessler, 2011). The research also speaks to the lessons that have been gleaned from states and schools that have provided 1:1 laptops to its students. Advice and guidance points to the need for advance planning before distributing laptops, supporting teacher professional development, developing appropriate funding models, program monitoring and refinement, and managing the cultural and institutional change necessary for a successful deployment (Bonifaz & Zucker, 2004). It is noted that while the research of Bonifaz and Zucker (2004) spoke to the lesson learned as a result of the distribution, it lacked specifics regarding the benefits to the academic growth and development of the students. As with other published reports regarding classroom technology and application, it did not address the benefits that such technology brings to the student experience, but instead focused solely on the logistical challenges to effectively creating such programs. In the article, two direct quotes offered evidence of the student benefit of 1:1 laptops. The first was from a former Governor of Maine and the second from the director of special projects from the Maine Department of Education. Both quotes spoke to the benefit of the laptops as being able to "level the playing field," with both officials offering their belief that access to a 1:1 laptop initiative would act as a vehicle to help create equity and equal access to educational opportunity as part of an overall approach to teaching and learning. Technology usage, often in the form of programs like 1:1 laptop programs, has often been used as an example of how schools can redress historically economically challenging issues, and help to close the economic divide that too often separates students from learning (Warschauer, 2004).

The Abell Foundation in 2008 published *One-to-One Computing in Public Schools*, and in their report highlighted the case for this type of ubiquitous computing by outlining four key goals: increase academic achievement; transform the quality of instruction and the type of learning, leading to a higher level of student engagement; increase equity of access and minimize the digital divide; and increase the economic competitiveness of students and region by employing technology to teach twenty-first century skills. As a follow-up to this broad swath of goals, the Abell Foundation synthesized the findings that came from three statewide 1:1 laptop programs. Maine, Michigan, and Texas were profiled, and the scope of the initiative was detailed regarding logistical structure, cost, and findings.

The Maine initiative consisted of the eventual distribution of 100,000 computers to students participating in the Maine Laptop Teaching Initiative (MLTI), along with giving the technology to the students and regional training centers, the appointing of mentors, and the creation of statewide technology specialists. A series of evaluations were published in April 2007 and October 2007 and used a variety of sources to evaluate the effectiveness of the program—longitudinal surveys, site visits and observations, analysis of documents, and a controlled experimental study measuring mathematics progress statewide. The core findings of the studies were as follows:

- There were no appreciable changes, except for writing, on the Maine Education Assessment (MEA).

- The writing portion of the MEA improved significantly between 2000 and 2005. On average, students in 2005 had a higher score than approximately two thirds of all students in 2000. There was an increase in laptop use over the course of the writing process (drafts, edits, and final copy).
- Most importantly, greater levels of laptop use were linked to significant increases in writing scores.

In regard to the impact on instruction and learning, a majority of the teachers agreed that students were more engaged when using laptops and that the quality of student work improved as a result. Yet fewer than one-third of teachers, when surveyed, agreed that students were better able to understand class content when using laptops. The report made the following conclusions: students were more motivated to learn, teachers were helping students meet the state learning standards, and the laptop program was positively impacting how knowledge is acquired.

Similar to Maine's experience, Michigan instituted the Freedom to Learn (FTL) program in 2002. The goal was to help students develop independent skills as self-directed, self-sustaining learners. Fifteen schools and a total of 7,200 learners in the middle grades were given wireless laptops and handheld devices. By 2008, this program was expanded to include 30,000 students and 1,500 teachers in 200 schools statewide. Along with the distribution of devices and the accompanying adjustment to classroom practice, thousands of Michigan educators have participated in professional development activities.

The findings regarding the 1:1 initiative were as follows:

- Student interest and learning, along with the belief that 1:1 technology made schoolwork easier, was shared by the majority of students.
- Teachers reported greater use of student-centered practices, as well as greater student motivation and technological skills.

- Teachers further reported a belief that instruction and learning improved when students engaged in one-to-one computing.

Yet Michigan took no significant steps to find a statistically significant connection to the use of 1:1 laptops and the statewide administration of the Michigan Educational Assessment Program (MEAP). The co-author of the Michigan study, Dr. Steven Ross, stated that ". . . (The MEAP) like all state tests is a high stakes multiple-choice assessment that seemingly has little direct connection with the real-world skills that laptop students are acquiring" (p. 6). Further, there is no indication that such analysis will take place.

The final statewide distribution occurred in Texas; titled the Texas Technology Immersion Project (TIP), it included the distribution of laptops to 7,873 students and 636 students in 2004 and 2005, respectively. By 2006, financial limitations required the scaling back of the program, and funding continued for only 22 middle schools. Due to limitations in state reporting, the actual number of teachers and students who received laptops that year is unknown.

As with other states, the findings in Texas revealed the following:

- Student technology proficiency and engagement increased significantly and closed the gaps that existed before the laptop program.
- Student disciplinary cases dropped in classrooms that used 1:1 laptops as part of the regular instructional day.

In contrast to other states that showed no state-assessment improvement (Maine) or did not measure it at all (Michigan), Texas reported the following findings:

- Reading, social studies, writing, and science reading scores on the Texas Assessment of Knowledge and Skills (TAKS) either had no statistically significant effect or any impact was inconclusive.

- The immersive nature of the laptop program, especially for students who were considered economically advantaged or higher achieving, had a statistically significant impact on the TAKS mathematics scores.
- Greater access to the laptop outside of school led to higher TAKS scores in the areas of reading and math.
- The positive impact of immersion grew over time, with third-year participants showing greater improvement on TAKS scores.

While a lengthy piece of research to cite as part of a literature review, the Abell Foundation report showed several key findings across states and across varying implementation plans and offered insight for those striving to understand the research base evaluating the effectiveness of 1:1 laptop initiatives. First, student engagement, as defined by positive student behavior, increased, including class collaboration between classmates, a stronger focus on classwork, and growth in technology proficiency with access to technology. Second, teachers reported higher student engagement as shown by attentiveness to academic material, increased attention during class, and better behavior choices. Third, there was no significant connection, at least in the case of these three states, to show that traditional state test assessment increased as a result of 1:1 laptop programs.

Classroom Impact on a Local Level

Moving from a wide-lens, macro view of the state and local research involving the adoption of 1:1 laptop programs, much research has been conducted that speaks to the impact of these programs on the classroom. Along with the statewide 1:1 laptop initiatives, the work of individual districts speaks to the application of 1:1 laptops in the classroom. In 2001, 60 sixth-graders in the Pleasanton Unified School District of California began a 1:1 program with the group eventually growing to a total of 259 students. This represented 25% of the district's middle school students. Pilot group participants achieved higher test scores than similar students who did not have access to laptops as part of their regular instruction. This success was found per student academic grades in mathematics, writing, and English Language Arts classes in addition to having strong school performance as measured by grade point averages (Group, 2006).

The use of laptops has also spread across national borders, with Peace River North School District in Western Canada adopting laptops in an attempt to address gender-based discrepancies on district writing assessments. After two years of 1:1 laptop usage, the gap had closed significantly, with boys drawing even with girls with 88% and 89% proficiency. In addition to helping close the gender gap, the laptop initiative was also credited with increasing district wide scores for both genders (Group, 2006).

The literature also speaks to the use of laptops in higher education, with research being conducted regarding the impact on student self-reported attention to class material and the overall connection to course performance. Research has shown that laptops, while increasing student involvement and interest, do not share a statistically significant connection to improving student academic achievement (Fried, 2008). In addition to the lack of impact on student achievement, a concern in regard to some of the current literature is that the studies supporting the use of laptops focused almost solely on student perception of the devices or took place in classes that were exclusively designed around the technology in question. Fried (2008) noted that the studies conducted thus far, while meeting expectations for quality scholarship and objectivity, appear to lack a focus on technology integration into the traditional classroom setting.

Research has spoken to the use of 1:1 laptops at the state, local, and higher education levels; and while there has been a broad variety of implementation types and research studies conducted on the efficacy of 1:1 laptop initiatives, there is no clear consensus regarding this implementation model. Turning attention away from these individual cases, there is a significant body of research that has attempted to offer a meta-analysis on the effects of computer-aided instruction on student achievement.

Meta-analysis of Computer-assisted Instruction

Christmann et al. (1977) published a seminal study with the goal of providing a meta-analysis of the impact of computer-assisted instruction (CAI) on the student academic experience. Starting with a research study load of over 1,800 publications, they were able to winnow that list down to 39 relevant publications that met their strict criteria of taking part in an educational setting, included quantitative results in which academic achievement was the dependent variable and computer-assisted instruction was the treatment, had an experimental, quasi-experimental, or correlational research design and a sample size of at least 20 students. The collected data were then analyzed using a meta-analysis procedure, a technique that relies heavily on the calculation of effect sizes for overall meaning. To prevent publication bias, as many of the studies came from pro-technology sources and journals, the authors elected to include 15 dissertations and eight unpublished articles. The meta-analysis revealed that CAI positively affected the academic achievement of elementary school students. The mean effect size calculation across the 68 conclusions of the 39 studies generated by the meta-analysis was 0.342. This effect size is interpreted as small (Cohen, 1977). The difference in academic achievement as a result of CAI was a growth of 13.31 percentile ranks from the central region of the distribution. As a result, the conclusion can be drawn that CAI is more effective than traditional methods of instruction in raising overall academic achievement among elementary school students. The authors concluded by stating that the results should not be viewed as indicating that CAI is completely effective in raising student achievement but rather that the "look back" nature of meta-analysis requires more research to occur to support the findings. This conclusion offers support to the research imperative of the need for this study.

Another meta-analysis was conducted in 2003 that evaluated the effectiveness of teaching and learning with technology on student outcomes. Similar to Christmann et al.'s 1997 study, Waxman and his fellow researchers (2003) conducted a meta-analysis consisting of 282 effect sizes compiled from 42 studies with a combined sample size of 7,000 students. Initially, over 200 potentially applicable articles were considered for analysis, with 42 meeting the criteria for the synthesis.

Based on the meta-analysis, the mean of the study-weighted effect sizes averaging across all outcomes was .410 ($p < .001$), with a 95% confidence interval (CI) of .175 to .644. This result indicated that teaching and learning with technology had a positive and small significant ($p < .001$) effect on student outcomes when compared to traditional classroom practices. The mean study-weighted effect size for the 29 studies containing cognitive outcomes was .448, and the mean study-weighted effect size for the 10 comparisons that focused on student affective outcomes was .464. Yet, and in contrast, the mean study-weighted effect size for the three studies that contained behavioral outcomes was -.091, indicating that technology had a small, negative effect on students' behavioral outcomes. These outcomes were defined, among other expectations, as attending to academic tasks, focusing on classwork, being a productive group member and completing assignments. The overall study-weighted effects were constant across the categories of study characteristics, quality of study indicators, technology characteristics, and instructional/teaching characteristics. For the purpose of understanding the technology used in the studies contained in the meta-analysis, 30% of the studies used personal computers; 26% used networked laboratories; 5% used multimedia; and the other 39% used a broad variety of technological resources. The synthesis of the quantitative data showed a modest, positive effect of teaching and learning with technology on student outcomes. The mean effect size of .410 was higher than the median of other recent meta-analyses (Waxman et al., 2003).

Further, the results, as they revealed no significant differences across the categories of study quality, teaching, and technology characteristics, can be generalized across a wide variety of conditions that have been researched, as well as across the various demographics of student, school, and study types. From this review of the meta-analysis, the researchers were generally encouraged by the results. The overall effects were nearly twice as large as other recent meta-analyses. This finding suggested that the overall effect of technology on student outcomes may be more positive than previously known and encouraged further research to investigate the connection between 1:1 laptop initiatives and its impact on student achievement.

As technology adoption continues, it is clear that the continued expansion of newer and newer learning options will never stop impacting the classroom; and, along with that, the things that students will learn will continue to evolve. As policy makers and practitioners continue to make equipment, staffing, and curricular decisions, there will be the appearance of new literacies required for our students to be productive and involved workers and citizens. Among them are collaborative work skills, the ability to synthesize information from a variety of sources, and the need to use technology to gain a greater understanding of the mathematical and logical reasoning necessary to solve complex problems (Collins & Halverson, 2010). The literature has repeatedly shown that the introduction of 1:1 laptop technology, in order to be effective, has forced a re-evaluation of what takes place in the classroom. It is from this knowledge base that this study takes its inspiration. It is essential that student achievement, as it relates to the use of 1:1 laptops in the classroom, be evaluated to better understand the impact of those laptops' broad and comprehensive use in our schools.

Student Variables and Academic Achievement

The purpose of this study was to examine the effects of a one-to-one (1:1) laptop initiative on the academic achievement of students at a 9th through 12th grade suburban New

Jersey high school as measured by the High School Proficiency Assessment in English Language Arts and Math. Additionally, the study examined the impact of other student mutable variables such as gender, socioeconomic status (as measured by the utilization of free/reduced lunch), class attendance, special education status, and English language proficiency on the dependent variable, which was defined as student achievement on the High School Proficiency Assessment in English Language Arts and Math administered as part of a student's exit exam requirements to earn a New Jersey high school diploma.

Examining other student variables was necessary, as those variables may have an impact on student achievement as measured by student achievement scores. Propensity score matching was used to isolate the variable of 1:1 laptop usage on student academic achievement as measured by scores on standardized tests. However, the impact of these variables led to a review of current literature on the impact of gender, socioeconomic status, class attendance, special education status, and English language proficiency on the dependent variable.

Gender

Gender is often explored when analyzing variables as they relate to student achievement. There are mixed results when analyzing empirical studies regarding the presence of an achievement gap between boys and girls (Cheema & Galluzzo, 2013). While Cheema and Galluzzo's (2013) analysis of the quadrennial Trends in International Mathematics and Science Study (TIMMS) revealed a significant gender-based gap on some assessments, there were other assessments within the same testing period that showed little to no difference regarding gender and performance. This lack of gender difference consistency across the different components of the test showed that a clear conclusion regarding gender cannot be drawn.

Yet, a significant gender gap, especially as it relates to math performance, has been noted (Fryer & Levitt, 2010). In this study, an analysis of the gender differences regarding test results was noted between boys and girls. Even though students in the study entered school at roughly the same level, by third grade the gender gap was pronounced and continued to grow. In addition, student results on both the TIMMS and The Program for International Student Assessment (PISA), showed that the gender gap was pronounced across all countries but was less in countries that had more gender equality; i.e., Sweden, to the point that it was almost non-existent.

It is important to note that while there is a wide variety of research that offers inconclusive data on the impact of gender on student achievement, individual differences in achievement have been noted across gender lines. One example of this may be found in Voyer (2014), whose meta-analysis of 502 effect sizes drawn from 369 samples revealed a consistent female advantage in school grades for all course content areas. Further, Voyer cited Patrick (1999), who found that extrinsic rewards are ultimately demotivating for young men and negatively impact academic achievement.

A number of factors should be considered when analyzing the differences in academic achievement based on gender. These factors include geographic location (Pope & Sydnor, 2010), socioeconomic status (Parke & Keener, 2011), biology (Niederle & Vesterlund, 2010), ethnicity (Parke & Keener, 2011), school climate (Legewie & DiPrete, 2012), and socialization (Nowell & Hedges, 1998). What these many theories offer is that a clear consensus on the variables that impact student achievement based on gender does not exist. This analysis of the research supports the overall belief that the impact of gender on student test results is still not conclusive, and with the diversity in research results, we should be cautious in accepting findings regarding gender and academic achievement.

That being understood, the lack of consensus does not make the impact of gender on academic achievement inconsequential. Rather it speaks to the ongoing need for more research in this area. Brophy's (1985) interest in the difference in academic achievement between genders centered on the possibility that boys were being outperformed by girls during elementary school. The research shows that girls tend to enjoy an advantage over boys in reading and related subjects, such as writing and spelling, through elementary school and continuing into the adolescent years (Dwyer & Johnson, 1997). Boys have traditionally enjoyed an advantage over girls in achievement test scores in math but not in science. This is a typical misconception (Hyde, Fennema, & Lamon, 1990). Considered overall, girls tend to outperform boys across school subjects during the elementary years, but this edge tends not to manifest itself on math-based achievement tests.

Socioeconomic Status

Socioeconomic status (SES) has a tremendous impact on academic achievement. As noted by Tienken (2012), "Without a doubt, poverty has a negative influence on student achievement, especially when achievement is measured by state-mandated standardized tests" (p. 105). This has been repeatedly shown in multiple studies, and students who come from homes with lower incomes are at an increased risk for lower grades, retention, and suspension or removal from school. They are also more likely to perform more poorly academically than wealthier peers and are more likely to underperform on state assessments or be classified with learning disabilities (Sirin, 2005; Caldas & Bankston, 1997).

The Coleman Report (1966) is considered a seminal document in the longstanding and broad research base regarding student achievement and the connection to socioeconomic status. Authorized by the Civil Rights Act of 1964, the report found that the "social composition of the student body is more highly related to achievement, independent of the student's own social background, than is any school factor" (p. 325). Further, it was noted by

Coleman that when placed in schools of higher socioeconomic backgrounds, students from less-wealthy areas performed at higher academic and social levels.

The correlation between socioeconomic status and academic achievement was further supported in a meta-analysis of almost 200 studies (White, 1982). The socioeconomic gap exists before children enter school and only grows over time due to the continued limitations of their home environment. This significant impact on academic achievement, one of the strongest predictors of student success, can be addressed through economic integration, as such an intervention is a powerful method to close the gap between poor and wealthy students when compared to other school-based reforms (Schwartz, 2011). In addition to that research, Stull (2013) found that a child's achievement was most strongly related to the family's SES. A wide-ranging study of 900 kindergarten programs with a total population of 22,000 students was used. All stakeholders were involved—parents, teachers, administrators, and students—in the study. Stull found that a child's academic achievement was most strongly correlated to the family's SES. The regression coefficient was 3.389 and the beta was 0.285.

Warschauer (2004) further studied student SES, academic achievement, and access to technology. Via his work, it was established that while the student-computer ratios in schools were similar, the in-class and social context of computer use was different. Low-SES schools were impacted by uneven human-based technology supports, inconsistent access at home to online resources, and school-based pressures to use the technology for the primary purpose of raising high-stakes test scores. The socioeconomic status dividing line between access, support, and use of technology was further investigated by Becker (2000) via a national survey. The research showed that low-SES student computer use was actually greater than high-SES student computer use but that the use consisted of computer-based drills for the purpose of standardized tests, whereas the high-SES students used computers less often but for higher-level simulations and research. The use of new technology by low-SES and/or Hispanic or Black students for the purpose of drill as opposed to the use of technology for more academically challenging purposes by high-SES or Asian and White students was further found by Wenglinsky (1998).

Page (2002) compared the educational attainment of elementary students in technology-centered classrooms to those in traditional classrooms in terms of classroom interaction, self-esteem, and student achievement. The sample was composed of 211 students of low-socioeconomic status. From the research, it could be concluded that students from lower socioeconomic backgrounds experienced a rise in their self-esteem as part of the technology-enriched classrooms. From this conclusion, Page connected a rise in self-esteem due to technology usage as being a positive precursor to increasing one's socioeconomic status. Page based this connection on the research of Lehrer and Randle (1987) that discussed the positive relationship between rising self-esteem and an eventual ability to raise one's socioeconomic status. This conclusion was also supported by Gardner, Simmons, and Simpson (1992), who suggested that such technology enrichment, beyond aiding the knowledge gains of classroom students, encouraged lifelong learning habits and helped to connect students to extended learning and school attendance.

Class Attendance

The connection between the variable of academic achievement and school attendance has been documented in numerous studies (Roby, 2004; Sheldon, 2004). This has been an exhaustively researched topic from grades K-12, and the research has shown that students score lower on high-stakes tests when they have difficulty making it to school. This is based on studies that examined attendance and school attendance in Grades K-12. Along with the firm connection between attendance and academic achievement, studies have also supported that there is a significant impact on attendance and success on standardized test scores. Parke and Kayongo (2012) analyzed over 32,000 state test math results from a single school district. Using these math assessments as a measure of student academic achievement, the study indicated that student mobility, when combined with low attendance, had a negative impact on student academic achievement in math. In addition, it was also revealed that various ethnic subgroups shared similar trends regarding school attendance and academic achievement (Parke & Kanyongo, 2012).

In addition to the connection between class attendance and student academic achievement, it is important to note that chronic absenteeism is especially impactful for students with disabilities. Recognizing that they are already experiencing learning-based challenges, students with disabilities are more likely than their non-disabled peers to miss school (Spencer, 2009); in fact, as Spencer further noted, students with disabilities missed 15% to 20% more instructional time as compared to typical students who were not managing the challenge of a learning disability. It is important to consider student attendance as a variable when conducting research regarding the impact of an independent variable on student academic achievement (Parke & Kanyongo, 2012).

Special Education Status

Per the 2010 U.S. Census, of the 53 million school-aged children (aged 5-17) in the United States, roughly 2.8 million (5.2% of the overall population) were reported to have a learning disability requiring some form of remediation in school. When expanding the definition to include all students with all disabilities, the number grew to 6.4 million (12.9% of the overall population). Since 2010, the classification rates of students with learning disabilities have leveled off. When taken in combination with the total number of students with disabilities, the capacity for laptops to significantly alter the learning environment and the legal requirements to offer individualized education plans offer support for further research into the connection between 1:1 laptop initiatives and their impact on the teaching/learning environment.

Research has shown that in special education classrooms, the use of laptops among special needs students seems to be an effective learning tool that offers the kind of success that might not otherwise be available. The educationally assistive technology available via laptops and other digital media enables a high level of adaption for the student, especially as it relates to individually relevant factors (Mioduser, Nachmias, Tubin, & Forkosh-Baruch, 2004). Of particular interest is the capacity of laptops to offer immediate and on-the-spot word processing functions—spelling correction, syntax analysis, and access to an electronic dictionary—as well as provide strong support for students with handwriting and penmanship challenges. Hezroni and Shrieber (2004) examined the effect of computer-aided word processing assistance on the performance of students with dysgraphia. Students made fewer errors when using the laptop to read their work aloud, and the reading contained greater fluency. Students were also able to locate information in their writing more easily, as well as have an overall more legible experience. These findings offer support for the belief that computer software has the capacity to support and develop the growing literacy skill capacity for students with learning disabilities.

Conclusion

There is a considerable body of literature on the impact of 1:1 laptop programs on academic achievement (Saettler, 1990: Christmann et al., 1977; The Abell Foundation, 2008). In most cases, the research has indicated mixed results for this use of technology, with varying statistical significance on academic achievement. As many as 33 states have undertaken 1:1 laptop initiatives; and while research has illuminated the logistical and deployment lessons found in such initiatives, deeper analysis of the academic impact is warranted (Bonifaz & Zucker, 2004). This research will add to the limited body of research that exists on the influence of 1:1 laptops on student achievement so that educational leaders may make informed decisions about the most appropriate technology and learning environment for secondary students.

CHAPTER III

METHODOLOGY

The purpose of this study was to examine the impact of a 1:1 laptop initiative on student achievement in a 9th through 12th grade suburban New Jersey District. Additionally, the impact of other mutable variables among students, such as gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, and status as an English Language Learner, on the dependent variable as covariate, defined as student achievement on the 2014 administration of the High School Proficiency Assessment (HSPA) and 2011 administration of the Assessment of Skills and Knowledge (NJASK), was also examined.

By focusing on the effect of 1:1 laptop use as part of regular classroom instructional practice, the study was aimed at producing research-based evidence to assist in determining if a 1:1 laptop initiative might influence the student achievement of student laptop users. The study could add to the limited research that exists regarding the impact of 1:1 laptop use on student achievement, which could lead to further research in the area.

This study utilized a quasi-experimental, explanatory design. Subjects were members of either a treatment (use of a laptop on a 1:1 basis) group or control (no use of a laptop on a 1:1 basis) group and were analyzed with quantitative methods. In this case, student populations from two separate high schools were studied based on the existence, or lack thereof, of a schoolwide, ubiquitous 1:1 laptop program. The study was conducted to explain the influence of the target variable of laptop usage on student achievement as it relates to student achievement on the Math and Language Arts Literacy (LAL) portion of the New Jersey High School Proficiency Assessment while controlling for other school, student, and staff variables.

This chapter is designed to offer an overview of the methodology used as part of this research study. It includes the pertinent research questions and accompanying null hypotheses and an explanation of the research design, including the use of propensity score matching as the sampling protocol necessary to reduce selection bias and to replicate a randomized design. Further, an overview of the sample population/data source is offered, including an explanation of the demographic factors that play a role in the results of the study. This chapter enables a full and complete understanding of the research questions being asked, the design of the study, and the population that is being studied, as well as the type of analysis being used for a better understanding of the applicable data.

Research Questions

The following research questions guided this study:

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypotheses

Null Hypothesis 1: There is no significant impact on a student's HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics Performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 3: There is no significant impact on a student's PSAT Performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

Null Hypothesis 4: There is no significant impact on a student's HS GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Research Design

This study was conducted as a quasi-experimental, explanatory design using propensity score matching (PSM) as a sampling protocol in order to reduce selection bias and replicate a randomized design. Subjects came from two separate, suburban New Jersey 9th through 12th grade high schools and were assigned to treatment and control conditions as determined by their participation in a ubiquitous 1:1 laptop program.

Sample Population/Data Source

The participants in this study were selected from two suburban middle to upper-middle class 9th through 12th grade high schools in northern New Jersey. For the purpose of anonymity and data protection, each school was labeled with a non-identifier.

Table 1

High School District Data

	BHS	FHS
School Population	555	1,085
Town Population	8,710	19,643
District Factor Group	I	I
Racial Makeup	White - 57.9% Black - 0.4% Hispanic - 9.1% Asian - 32.1 % Two or more - 0.5%	White - 71.1% Black - 1.1% Hispanic - 6.5% Asian - 20.9% Pacific Islander - 0.1% Two or more - 0.4%
Median Household Income	$97,276	$121,552
1:1 Laptop Program	No	Yes, Grades 9-12
Student Classification Rate	12%	14%

Economically Disadvantaged Students	4.2%	0.7%
Limited English Proficiency Students	2.7%	1.0%
% of students participating in SAT or ACT	97%	95%
% of students participating in PSAT	78%	70%
% of students scoring above 1550 on SAT	66%	65%

Table 2

Research Study Cohort Data

	BHS	FHS
Class Population	124	122
Racial Makeup	Asian – 28% White – 61% Hispanic – 11%	Asian – 13% White – 80% Hispanic- 6% Multiracial – 1%
Gender Makeup	Male – 49.2% Female – 50.8%	Male – 45.9% Female – 54.1%
Student Classification Rate	10%	12.3%
Economically Disadvantaged Students	4%	6%
Limited English Proficiency Students	0.0%	0.0%

The two high school districts draw from a variety of local and regional school population structures. BHS is a single-town district in which all town residents have the option of attending the local kindergarten through 12th grade schools. FHS is a regional high school district in which two towns send students to 7th through 12th grades. For the purpose of this study, participants were drawn from the graduating class of 2016. Participants were each drawn from a single town. It should be noted that while FHS is a regional school district, data from a single town's students were used for this research study.

Study participants were included if they met the following criteria: (a) were a member of the respective high school's graduating class in June of 2016; (b) participated in the administration of the Math and Language Arts Literacy (LAL) sections of the New Jersey High School Proficiency Assessment (NJHSPA) as part of their high school career; and (c) participated in the Spring 2011 administration of the Math and Language Arts Literacy (LAL) sections of the New Jersey Assessment of Skills and Knowledge (NJASK).

Sampling Protocol: Propensity Score Matching (PSM)

Propensity score matching (PSM) offers researchers the ability to control for group differences when estimating treatment effects (Lane, To, Shelley, & Henson, 2012). This is necessary, as the type of randomized assignment with placement in either treatment or control groups, which would normally be used, is not readily available for studies done in a public school setting. Due to cost containment concerns and the unethical nature of random assignment for student placement, other options must be used to estimate more precise effect sizes by eliminating selection bias, which is inherent to observational studies (Adelson, 2013). It is here that PSM functions as a useful analytical tool. The mutable variables—class attendance, SES, special education status, gender, and past academic performance—were used for the propensity score. Creating matching "units" of students offered the ability to create a natural weighting scheme providing unbiased estimates of the overall impact of the treatment impact (Dehejia & Wahba, 2002).

In the case of this study, entire school populations were offered one of two possible effects: either the use or lack thereof of a 1:1 laptop for the purpose of their academic studies. PSM enables the researcher to pair like students in the sample population from the control and experimental groups. Per Stone and Tang (2013), "A propensity score is a single summary score that represents the relationship between multiple observed characteristics between control group members and treatment group members" (p. 23). As a result, students are paired with each other based on the similar nature of observable characteristics (Dehejia and Wahba, 2002). This single summary score, taken from a number of covariates, creates a propensity score that offers a more stable result (Adelson, 2013). This, in turn, enables the researcher to reduce bias and offer support for causation arguments. The U.S. Department of Education has recommended that PSM be used by researchers, but as yet it remains underused in educational research (Lane et al., 2012).

Data Analysis

Preliminary simultaneous multiple-regression models were performed on the PSM sample to determine the amount of variance in 2014 NJ HSPA scores, PSAT, GPA, and student attendance that could be explained by participation in a ubiquitous 1:1 laptop program. If appropriate, based on this preliminary analysis, hierarchical multiple regression was used to determine if there was value added based on student identification with a 1;1 laptop program.

The dependent variable was student performance on the 2014 NJ HSPA, while the target variable of interest was participation in a ubiquitous 1:1 laptop program. Other independent variables included as control variables were gender, socioeconomic status (SES), grade point average, ethnicity, school attendance, special education status, and English language proficiency, all of which have been identified in the literature as having a significant influence on student achievement. Simultaneous and hierarchical multiple regressions were conducted to analyze the direction and strength of the relationship between the target variable of interest and other school, student, and staff variables and student achievement as quantified by the NJHSPA LAL and Math scores. Whenever warranted, based upon the preliminary regression analysis, additional quantitative methods (i.e., ANOVA, ANCOVA, factorial ANOVA, factorial ANCOVA) were used to better explore and explain the overall influence of the target variable of interest on student achievement.

Table 3

Variable Coding

Variable	Measure	Coding
Gender	Nominal	0= Female 1= Male
SES/Free Lunch Eligible	Nominal	0= No 1= Yes
Grade Point Average	Scale	Scores Indicated
HSPA ELA 2014	Scale	Scores Indicated
Attendance	Scale	Number Indicated
ELL/LEP	Nominal	0= No 1= Yes
NJASK ELA 2011	Scale	Scores Indicated
Classified Special Education	Nominal	0= No 1= Yes
HSPA Math 2014	Scale	Scores Indicated
NJASK Math 2011	Scale	Scores Indicated
Days Absent	Scale	Number Indicated
PSAT Scores	Scale	Scores Indicated
Ethnicity	Categorical	1 = Asian 2 = Hispanic

		3 = White 4 = Multiracial

Instrumentation of NJ ASK 8 and NJ HSPA/Reliability/Validity

The goal of this study was to measure the impact of a 1:1 laptop initiative on student achievement. The depth and significance of this relationship can inform local school leaders and policy makers of the efficacy and impact of these programs.

Validity and reliability are of utmost importance when working with data and conducting a quantitative research study of this type. Fortunately, the New Jersey Department of Education has offered a technical report on the validity and reliability of the two instruments—the New Jersey Assessment of Skills and Knowledge (NJASK), and the New Jersey High School Proficiency Assessment (NJHSPA). Regarding the NJHSPA, this assessment quantifies the level of proficiency shown by students as it relates to their understanding of New Jersey's Core Curriculum Content Standards (NJCCCS) in the subject areas of Mathematics and Language Arts Literacy (LAL).

The origins of both state tests go back four decades to 1975 when, in the spirit of raising the standards and student experience of New Jersey students, the New Jersey Legislature passed the Public School Education Act. The overall goal was to offer all students in New Jersey, regardless of their backgrounds or geographic locations, the chance to be prepared to meet the political, economic, and social expectations for citizens in a democratic society. Further, an amendment was signed into law in 1976, establishing uniform standards of achievement in basic communication and computation skills. It is from this amendment that the NJ Department of Education draws the legal basis to present tests as graduation requirements for New Jersey students. It is from these humble beginnings, and through multiple iterations over the years; i.e., the use of the Early Warning Test (EWT) or the Elementary School Proficiency Assessment (ESPA), that New Jersey students have these assessment models as part of their school experience. As these assessments have evolved, up to and including New Jersey's current participation in the Partnership for Assessment of Readiness for College and Career (PARCC), educators, parents, and policy makers are presented with a wide variety of assessment and performance data with which to measure student, staff, and school performance.

The reliability of the NJHSPA was supported by the 2015 Technical Report published by Measurement, Inc. The NJHSPA uses a scale score from 100-300. Three proficiency levels are then established from student scores, and student performance is assessed as being Partially Proficient, Proficient, and Advanced Proficient. Students with scores below 200 are considered to be Partially Proficient; between 201 and 249, Proficient; and students scoring 250 and higher are classified as being Advanced Proficient. A minimum score of 200 is necessary in both the Math and Language Arts Literacy (LAL) for a student to be deemed Proficient in the respective content area. To create consistency across the state, help assist with analysis and application, and gain a better understanding of student performance, the NJASK and the NJ HSPA, while obviously testing for different curricular expectations due to student development levels, use the same proficiency level system.

The NJDOE ensures the reliability and validity of these tests by relying on Cronbach's alpha measure of internal consistency. Per Tavakol and Dennick (2011), Cronbach measured the internal consistency within a test through the development of alpha. Internal consistency is the degree to which all items on a test measure the same concept. Clearly, this is necessary to ensure that items are aligned in terms of what they assess. Further, determining internal consistency before the test is used ensures validity. Along with the internal measures to confirm reliability and validity, at least two readers are expected to read and hand-score each response. Training is conducted using actual student papers and consistency between raters is expected to create an accurate measure of student performance. A third reader is used in the event that there is a difference in the scores given by the first two readers.

Alignment between the NJ HSPA and the New Jersey Core Curriculum Content Standards (NJCCCS) is necessary to ensure test validity. Per the Technical Report (2011), the most important source of evidence to support the use of the NJ HSPA is its alignment with the NJCCCS. It is because of this validity that the test can be seen as an accurate measure of student understanding of the NJCCCS. Test questions are drawn from an available question source bank and are reviewed as part of a two-year cycle. To confirm validity, educators are involved in the test question review process and their expertise is relied upon in creating test content. Familiarity with the NJCCCS, the students being tested, and the goals and objectives of the test are expected from each of the involved educators. Their involvement extends beyond a review of the question bank and includes the ability to outright approve or reject test questions. As noted previously with the scale score consistency and usage between the NJ ASK and NJ HSPA, the same process is used to establish content for both tests.

Per the College Board (2016), the Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT) is a privately-produced, nationally-administered assessment used for the purpose of both exposing students to the rigors of the Scholastic Aptitude Test (SAT) and also functions as an identifying test for students who qualify as National Merit Scholars. It is traditionally offered to high school freshmen, sophomores, juniors, and seniors. The test consists of three sections—critical reading, mathematics, and writing—which measure math reasoning, writing, reading, and critical thinking skills. It is designed to not only measure in-class performance but to draw upon skills developed over years of study and experiences, both inside and outside the classroom. Each section is scored on a scale of 20 to 80, with the lowest score being 60 and the maximum being 240 points. By design, these can be compared to scores on the corresponding SAT section, as they range from 200 to 800.

Both schools included in this study compute Grade Point Average (GPA) as an overall indicator of student academic progress. Via their School Counseling Departments, both schools publish "School Profiles" which serve to introduce the school to colleges and universities, and also contains detailed information about how student GPA's are calculated. Below is a chart listing the specific mathematical criteria for GPA calculation.

Table 4

BHS GPA Grading Scale

Letter Grade	**Point Range**	**GPA**	**Letter Grade**	**Point Range**	**GPA**
A+	100-98	4.3	C+	79-78	2.3
A	97-93	4.0	C	77-73	2.0
A-	92-90	3.7	C-	72-70	1.7
B+	89-88	3.3	D+	69-68	1.3
B	87-83	3.0	D	66-67	1.0
B-	82-80	2.7	D-	65	.07

As seen below, FHS has uses a similar GPA calculation structure.

Table 5

FHS GPA Grading Scale

Grading Scale		
Grade	CP	Numerical
A+	4.00	97-100
A	3.77	93-96

A-	3.55	90-92
B+	3.33	87-89
B	3.00	83-86
B-	2.67	80-82
C+	2.33	77-79
C	2.00	73-76
C-	1.67	70-72
D	1.00	65-69
F	0.00	0-64

Data Collection

Permission was granted to this researcher to use all the requested resources by the two different school districts' superintendents of schools, as well as their respective boards of education. Data were collected from each district via their individual student information management systems and shared via Microsoft Excel spreadsheet. Confidentiality and anonymity were guaranteed by the use of student numbers, and student names were never given to the researcher; instead, a coded spreadsheet with non-student identifying numbers was used. The 2011 NJ ASK and 2014 NJ HSPA student results for both Math and Language Arts Literacy (LAL) were shared, along with student PSAT scores, gender, free/reduced lunch status, gender, final grade point average, ethnicity, attendance, special education status, and LEP/ELL status. There was no distinction made between students receiving a general education program versus a special education program, and all student data were included. If data were missing from a student record, he or she was not included in this study.

Conclusion

The purpose of this study was to explain the relationship between the use of a 1:1 laptop program in a suburban New Jersey high school and student achievement. With the increasing use of technology and the subsequent professional development and commitment of resources to support the use of laptops, this research can help to inform both policy and practice.

CHAPTER IV

ANALYSIS OF THE DATA

The purpose of this quantitative, quasi-experimental, comparative design was to explore the effect, if any, the implementation and comprehensive use of a 1:1 student laptop initiative at an upper middle class suburban New Jersey public high school has on student achievement.

This chapter includes a review of the research questions and null hypotheses that have guided this research study. Each question and hypothesis is addressed on an individual basis and each result is reported based upon the data analyses. Relevant conclusions are drawn and supported by both written analysis and accompanying data tables.

Research Questions and Null Hypotheses

Specific individual SPSS analyses were used to answer the following research questions:

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 1: There is no significant impact on a student's HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 4: There is no significant impact on a student's high school GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Propensity Score Matching

The final sample used for statistical analysis was obtained through the use of propensity score matching (PSM) to pair like students from the treatment school with like students from the control school. This was done in an effort to approximate more of a randomized design methodology and to reduce sampling bias. In educational research, with its possible ethical impact on students and cost implications, it is difficult to use randomized samples; and PSM helps to decrease the overall impact of selection bias inherent in nonrandomized, explanatory research designs. As per Lane and Henson (2010), PSM enables educational researchers to employ a statistical analysis strategy that has been widely used in many other fields of study. In addition, PSM assists in minimizing the impact of selection bias.

Through its elimination of differences due to demographic dissimilarities rather than treatment effects, PSM enabled the study of the effect of the predictor variables on student academic achievement at two separate schools. This quasi-experimental research design matched students from the control school (non-1:1 laptop initiative) with the treatment school (1:1 laptop initiative). Along with the ability to compare student academic achievement in this manner, PSM also offered the artificial structure of a randomized design methodology, which has been well-established as being one of the strongest methodologies of all research designs (Goodman & Blum, 1996).

For this specific study, all student data were collected and entered into an Excel file where it was properly dummy-coded. The Excel file was then loaded into SPSS statistical modeling software for the purpose of obtaining descriptive information and analytical results.

After PSM, 100 students were included in the sample from both high schools. Seven independent variables—gender, socioeconomic status (SES), ethnicity, special education classification, English Language Learner (ELL) status, past academic performance, attendance, and grade point average—were included in the PSM analysis. Forty-seven males and 53 females were included in the PSM sample. There were seven Hispanic students, 15 Asian students, and 78 White students in the sample. None of the students received free or reduced lunch, nor did any of them qualify as English Language Learners. Ninety-three of the students did not receive special education services, while seven did. The mean number of days absent was 8.50, with a standard deviation of 4.528. The mean scaled score on the 2011 administration of the New Jersey Assessment of Skills and Knowledge English Language Arts (NJASK 8 ELA) was 234.78, with a standard deviation of 19.647. The mean scaled score on the 2011 administration of the New Jersey Assessment of Skills and Knowledge Math (NJASK 8 Math) was 244.06, with a standard deviation of 37.638.

Results

In the original sample, 248 students from the combined high school class of 2015 from both schools were included. After eliminating students with incomplete data and missing assessment scores, a total of 193 students remained. Propensity score matching, as mentioned earlier, was used to select the sample. This enabled a comparatively randomized design and reduced selection bias. This was necessary for the use of the observational data present in this study. The independent variables included gender, SES (as determined by free and reduced lunch status), ethnicity, special education classification, English Language Learner status, grade point average, and past academic performance as measured by scaled scores on the student 8th grade administration of the New Jersey Assessment of Skills and Knowledge in both English Language Arts and Math. Coding for these variables is provided in Table 6.

Table 6

Variable Coding

Variable	Measure	Coding
Gender	Nominal	0= Female 1= Male
SES/Free Lunch Eligible	Nominal	0= No 1= Yes
Grade Point Average	Scale	Scores Indicated Scale Range (0.00 – 4.00)
HSPA ELA 2014	Scale	Scores Indicated Scale Range (100 – 300)
Attendance	Scale	Total number of days student was not present in school out of a possible 180 school days.
ELL/LEP	Nominal	0= No 1= Yes
NJASK ELA 2011	Scale	Scores Indicated Scale Range (100 – 300)
Classified Special Education	Nominal	0= No 1= Yes
HSPA Math 2014	Scale	Scores Indicated Scale Range (100 – 300)

NJASK Math 2011	Scale	Scores Indicated Scale Range (100 – 300)
Attendance	Scale	Number Indicated
PSAT Scores	Scale	Scores Indicated 60 – 240 possible points
Ethnicity	Categorical	1 = Asian 2= Hispanic 3= White 4 = Multiracial

Analysis and Results

Research Question 1/Null Hypothesis 1

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 1: There was no significant impact on a student's HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8).

In order to answer the first research question and the accompanying three null hypotheses, three separate analyses of covariance (ANCOVA) were run to assess the influence of a 1:1 laptop initiative on student academic performance as it relates to achievement of students on the 2014 High School Proficiency Assessment English Language Arts (HSPA ELA), High School Proficiency Assessment Math (HSPA Math) and the PSAT while controlling for student past academic performance as measured by the NJASK 8 ELA or Math, respectively. The NJASK 8 was used as an academic control variable because it measured student academic performance prior to students receiving a treatment.

Null Hypothesis 1: **ELA Results**

A univariate analysis of variance was run to test whether the assumption of the homogeneity of the regression slopes between the main effect and the covariate was met as is required of ANCOVA. Significant interaction (F (1, 96) = .193; p = .662) was not found between either the main effect or the covariate, indicating that this assumption was met (see Table 7). Consequently, an ANCOVA to determine significant differences on the 2014 HSPA ELA scores based on the main effect could be run.

Table 7

Results of the Test of the Assumption of the Homogeneity of the Regression Slopes

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	8470.023[a]	3	2823.341	29.656	.000
Intercept	10423.769	1	10423.769	109.491	.000
one2one	22.741	1	22.741	.239	.626
ask8ela	7564.662	1	7564.662	79.459	.000
one2one * ask8ela	18.347	1	18.347	.193	.662
Error	9139.417	96	95.202		
Total	6126416.000	100			
Corrected Total	17609.440	99			

a. R Squared = .481 (Adjusted R Squared = .465)

Levene's test of equality of error variances was not significant $p > .973$; consequently, the assumption for equality of variances was met for this ANCOVA.

The mean 2014 ELA score for students who did not participate in a 1:1 laptop program before the covariate was accounted for was 248.90, with a standard deviation of 12.046 (n=50), and the mean 2014 ELA score for students who did participate in the program before the covariate was accounted for was 245.42, with a standard deviation of 14.42 (n=50).

However, the estimated marginal means scores for the groups after the covariate was taken into consideration was 246.507 for those students who participated in a 1:1 laptop program and 247.813 for those students who did not, indicating a mean difference of 1.306 between the groups when the covariate was considered. As Table 7 indicates, this difference was not found to be statistically significant (F (1, 97) = .445; p = .506). However, as expected, the covariate NJASK 8 ELA was statistically significant (F (1, 97) = 83.314; $p <$ .001) and contributed 47% of the explained variance to the 2014 HSPA ELA.

Table 8

Results of Test of Between-Subjects Effects on 2014 HSPA ELA

Tests of Between-Subjects Effects

Dependent Variable: HSPA ELA

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	8451.676[a]	2	4225.838	44.761	.000
Intercept	10812.115	1	10812.115	114.523	.000
ask8ela	8148.916	1	8148.916	86.314	.000
one2one	41.990	1	41.990	.445	.506
Error	9157.764	97	94.410		
Total	6126416.000	100			
Corrected Total	17609.440	99			

a. *R* Squared = .480 (Adjusted *R* Squared = .469)

b. Computed using alpha = .05

Null Hypothesis 1 was retained, as evidenced by this data analysis. When controlling for prior academic achievement (NJASK 8 ELA), there was no statistically significant difference in student performance on the HSPA ELA based on whether the student participated in a 1:1 laptop initiative or did not participate.

Research Question 1/Null Hypothesis 2: Analysis and Results

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

In order to answer Research Question 1 and Null Hypothesis 2, a simultaneous multiple regression analysis was conducted. The goal of this analysis was to determine the amount of influence 1:1 laptop participation, gender, special education status, attendance, and standardized test taking had on Grade 11 student performance on the 2014 NJ HSPA Math test. A multiple regression model was required, as it was necessary to treat the covariates as separate predictors when measuring the effect of a 1:1 laptop program on student academic achievement.

This multiple regression analysis (Model 1) involved 100 students and examined the relative influence of six predictor variables on student performance on the 2014 administration of the NJ HSPA Math test. In this multiple regression model, the dependent variable was 11th grade performance on the HSPA Math test. The independent variables included 1:1 laptop participation, gender, special education status, attendance, and NJASK 8 Math performance. In the multiple regression model summary, the value of *R* squared was .670, which indicates that 67% of the variance in performance on the HSPA Math test can be explained by the independent variables (see Table 9). The adjusted *R* squared was .653, which indicates that with respect to the population from which the sample was drawn, the independent variables contributed to 65.3% of the variability in this regression model. The Durbin-Watson value for this model was 2.369, which indicates that the residuals were not related and the assumption for regression was met.

Table 9

Model Summary for Academic Achievement, 2014 HSPA Math

Model Summary[b]

Model	*R*	*R* Squared	Adjusted *R* Squared	Std. Error of the Estimate	Durbin-Watson
1	.819[a]	.670	.653	14.35830	2.369

a. Predictors: (Constant), 1 - 1 Participation, Gender, Special education, Attendance, NJASK 8 MATH

b. Dependent Variable: HSPA MATH

The regression model was statistically significant *(F* (5,94) = 38.231, *p*<.001) (See Table 8).

Examination of the standardized beta coefficients Table (see Table 10) indicates that there were four statistically significant predictors of performance on the HSPA Math test. They included gender, special education classification, NJASK 8 participation, and 1:1 laptop participation.

Table 10

Coefficients Table for Academic Achievement, 2014 NJ HSPA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	*t*	Sig.
1	(Constant)	145.983	11.915		12.252	.000
	Gender	-6.148	2.926	-.127	-2.101	.038
	Special Education	-22.899	6.558	-.241	-3.492	.001
	Attendance	.358	.333	.065	1.077	.284
	NJASK 8 MATH	.425	.045	.649	9.334	.000
	1 - 1 Participation	-7.960	2.903	-.164	-2.742	.007

a. Dependent Variable: HSPA MATH

Gender was a significant predictor of performance on the HSPA Math test. (β=-6.148, *t*=-2.101, *p*=.038), contributing 1.6% of the variance in this regression model as determined by squaring the value of the standardized beta coefficient (*b* = -.127). The negative beta indicates that males did better than females, scoring on average 6 points higher.

Special education status was a significant predictor of performance on the HSPA Math test. (β=-22.899, *t*=-3.492, *p* =.001), contributing 5.89% of the variance in this regression model as determined by squaring the value of the standardized beta coefficient (*b* = -.241). The negative beta indicates that general education students performed better on NJ HSPA Math testing, scoring on average 22 points higher than special education students.

Performance on the NJASK 8 standardized Math test was a significant predictor of performance on the HSPA Math test. (β=.425, t=9.334, *p*<.001). Previous performance on the NJASK 8 Standardized Math Test contributed to 42% of the variance in this regression model as determined by squaring the value of the standardized beta-coefficient (*b* = .649). The positive beta indicates that students who scored high on the NJ ASK 8 tended to score high on the NJ HSPA Math test.

Student participation in a 1:1 laptop program was a significant predictor of performance on the HSPA Math test. (β=-7.960, *t*=-2.742, *p* =.007); 1:1 laptop participation contributed to 2.7% of the variance in this regression model as determined by squaring the value of the standardized beta coefficient (*b* = -.164). The negative beta indicates that students who participated in 1:1 laptop programs tended to score lower on NJ HSPA Math. On average, they scored 8 points lower than those who did not participate in a 1:1 laptop program.

Based on this result, Null Hypothesis 2 for Research Question 1 was rejected. The implementation of a 1:1 laptop initiative had a statistically significant influence on student performance on the NJ HSPA Math test when controlling for gender, special education status, attendance, and previous academic performance. As a matter of fact, students who did not participate in a 1:1 laptop initiative tended to score higher than students that did participate.

Research Question 1/Null Hypothesis 3: Analysis and Results

Research Question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

A univariate analysis of variance was used to answer Research Question 1/Null Hypothesis 3. The ANCOVA assessed whether statistically significant differences were found among students who had access to a 1:1 laptop program as part of their overall high school academic program as opposed to those who did not. In this ANCOVA, past performance on the NJASK 8 ELA was treated as the covariate; and access to a laptop for the purpose of academic instruction was the main effect. The dependent variable was student performance on the PSAT while controlling for student past academic performance as measured by the NJASK 8.

Null Hypothesis 3: PSAT Results

A univariate analysis of variance was run to test whether the assumption of the homogeneity of the regression slopes between the main effect and covariate was met as is required of ANCOVA. Significant interaction ($F(1,96) = 2.08$; $p = .152$) was not found between the main effect and the covariate, indicating that this assumption was met (Table 10) Consequently, an ANCOVA to determine significant differences on the 2014 PSAT scores based on the main effect while controlling for student academic past performance could be run.

Table 11

Tests of Between-Subjects Effects

Tests of Between-Subjects Effects

Dependent Variable: PSAT

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	39742.640[a]	3	13247.547	46.523	.000
Intercept	4164.325	1	4164.325	14.624	.000
one2one	659.407	1	659.407	2.316	.131
ask8ela	35536.302	1	35536.302	124.796	.000
one2one * ask8ela	594.565	1	594.565	2.088	.152
Error	27336.520	96	284.755		
Total	2340540.000	100			
Corrected Total	67079.160	99			

a. R Squared = .592 (Adjusted R Squared = .580)

Levene's test of equality of error variances was not statistically significant at $p >$ .958; thus, the assumption for equality of variances was met for an ANCOVA.

The mean 2014 PSAT score for students who did not participate in a 1:1 laptop program before the covariate was accounted for was 155.34, with a standard deviation of 23.472 (n=50), and the mean 2014 PSAT score for students who did participate in the program before the covariate was 146.220, with a standard deviation of 27.848 (n=50).

The estimated marginal means scores for the groups after the covariate was taken into consideration was 149.088 for those students who participated in the 1:1 program and 152.472 for those students who did not participate in the 1:1 program, indicating a mean difference of 3.384 between the groups when the covariate was considered. As Table 11 shows, this difference was found not to be statistically significant (F (1,97) = .973; p = .326). However, the covariate NJASK 8 ELA was statistically significant (F (1,97) – 128.73: p <.000) and contributed 57% of the explained variance to the 2014 PSAT performance scores.

Table 12

Tests of Between-Subjects Effects on the 2014 PSAT

Tests of Between-Subjects Effects

Dependent Variable: PSAT

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	39148.075[a]	2	19574.037	67.977	.000	.584	135.955	1.000
Intercept	4641.199	1	4641.199	16.118	.000	.142	16.118	.978
ask8ela	37068.715	1	37068.715	128.733	.000	.570	128.733	1.000
one2one	280.151	1	280.151	.973	.326	.010	.973	.164
Error	27931.085	97	287.949					
Total	2340540.000	100						
Corrected Total	67079.160	99						

a. R Squared = .584 (Adjusted R Squared = .575)

b. Computed using alpha = .05

Null Hypothesis 3 was retained as evidenced by this data analysis. When controlling for prior academic achievement (NJASK 8), there was no statistically significant difference in student performance on the PSAT based on whether the student participated in a 1:1 laptop initiative or did not participate.

Research Question 2/Null Hypothesis 4

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 4: There is no significant impact on a student's high school GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

In order to answer the second research question and the accompanying null hypothesis, an analysis of covariance (ANCOVA) was run to assess the influence of a 1:1 laptop initiative on student academic performance as it relates to student grade point average (GPA).

Null Hypothesis 4: **GPA results**

A univariate analysis of variance was run to test whether the assumption of the regression slopes between the main effect and the covariate was met as is required of ANCOVA. Significant interaction (F (1,96) = .351; p = .555) was not found between either the main effect or the covariate, indicating that this assumption was met (see Table 12). Consequently, an ANCOVA to determine significant differences on student GPA based on the main effect could be run.

Table 13

Results of the Test of the Assumption of the Homogeneity of the Regression Slopes

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	2.315[a]	3	.772	3.645	.015
Intercept	243.344	1	243.344	1149.477	.000
one2one	.137	1	.137	.648	.423
att	.210	1	.210	.994	.321
one2one * att	.074	1	.074	.351	.555
Error	20.323	96	.212		
Total	1179.386	100			
Corrected Total	22.638	99			

a. *R* Squared = .102 (Adjusted *R* Squared = .074)

Levene's test of equality of error variances was not significant (p = .267); consequently, the assumption for equality of variances was met for this ANCOVA.

The mean 2015 GPA for students who did not participate in the laptop program before the covariate was accounted for was 3.542, with a standard deviation of .498 (n=50), and the mean 2015 GPA for students who did participate in the laptop program was 3.259, with a standard deviation of .478 (n=50).

However, the estimated marginal means scores for the groups after the covariate was taken into consideration was 3.263 for those students who participated in a 1:1 program and 3.539 for those students who did not participate in the 1:1 program, indicating a mean difference of .276 between the groups when the covariate was considered. As Table 13 indicates, this difference was found to be statistically significant (F (1, 97) = 8.949, p = .004). However, the covariate attendance was found not to be statistically significant (F (1,97) = 1.135, p = .289) and only contributed .01% of the expected variance to student grade point average.

Table 14

Tests of Between-Subject Effects

Tests of Between-Subjects Effects

Dependent Variable: Grade Point Average

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	2.241[a]	2	1.120	5.328	.006	.099	10.657	.829
Intercept	244.537	1	244.537	1162.896	.000	.923	1162.896	1.000
att	.239	1	.239	1.135	.289	.012	1.135	.184
one2one	1.882	1	1.882	8.949	.004	.084	8.949	.842
Error	20.397	97	.210					
Total	1179.386	100						
Corrected Total	22.638	99						

a. *R* Squared = .099 (Adjusted *R* Squared = .080)

b. Computed using alpha = .05

Null Hypothesis 4 was rejected as evidenced by this data analysis. When controlling for student attendance, the effect of a 1:1 laptop initiative on the academic achievement of students in a 9th-12th grade upper middle class suburban New Jersey public school district was statistically significant. Students who did not participate in a 1:1 laptop initiative had a significantly higher GPA than those who did participate in a 1:1 laptop initiative when controlling for attendance.

Research Question 2/Null Hypothesis 5

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education status, status as an English language learner, and student prior achievement (i.e., NJASK 8).

In order to answer the second research question and the accompanying null hypothesis, an analysis of covariance (ANCOVA) was run to assess the influence of a 1:1 laptop initiative as it relates to student school attendance while controlling for student grade point average.

Null Hypothesis 5: **School Attendance**

A univariate analysis of variance was run to test whether the assumption of the homogeneity of the regression slopes between the main effect and the covariate was met as is required of ANCOVA. Significant interaction (F (1,96) = .392; p = .584) was not found between either the main effect or the covariate, indicating that this assumption was met (see Table 14). Consequently, an ANCOVA to determine the significant differences regarding student attendance based on the main effect could be run.

Table 15

Results of the Test of the Assumption of the Homogeneity of the Regression Slopes

Tests of Between-Subjects Effects

Dependent Variable: Attendance

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.
Corrected Model	105.618[a]	3	35.206	1.756	.161
Intercept	251.028	1	251.028	12.521	.001
one2one	10.574	1	10.574	.527	.469
GPA	35.219	1	35.219	1.757	.188
one2one * GPA	6.064	1	6.064	.302	.584
Error	1924.629	96	20.048		
Total	9263.750	100			
Corrected Total	2030.248	99			

a. R Squared = .052 (Adjusted R Squared = .022)

Levene's test of equality of error variances was not significant (p = .846); consequently, the assumption for equality of variances was met for this ANCOVA.

The mean student school attendance, as measured by days absent, for students who did not participate in a 1:1 laptop program before the covariate was accounted for was 7.72, with a standard deviation of 4.218 (n=50); and the mean student school attendance, as measured by days absent, for students who did participate in a 1:1 laptop program was 9.29, with a standard deviation of 4.73 (n=50).

However, the estimated marginal means scores for the groups after the covariate was taken into account was 9.191 for students who participated in a 1:1 program and 7.819 for students who did not participate in a 1:1 program, indicating a mean difference of 1.372 between the groups when the covariate was considered. As Table 15 indicates, this difference was not found to be statistically significant (F (1,97) = 2.301, p = .133). The covariate student grade point average was also not found to be statistically significant (F 1,97) = 1.906; p = .171) and only contributed 1.9% of the explained variance to student attendance.

Table 16

Table of Tests of Between-Subjects Effects

Tests of Between-Subjects Effects

Dependent Variable: Attendance

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	99.554[a]	2	49.777	2.501	.087	.049	5.002	.491
Intercept	261.626	1	261.626	13.144	.000	.119	13.144	.948
gpa	37.931	1	37.931	1.906	.171	.019	1.906	.277
one2one	45.809	1	45.809	2.301	.133	.023	2.301	.324
Error	1930.694	97	19.904					
Total	9263.750	100						
Corrected Total	2030.248	99						

a. R Squared = .049 (Adjusted R Squared = .029)

b. Computed using alpha = .05

Null Hypothesis 5 was retained as evidenced by this data analysis. When controlling for student attendance, the effect of a 1:1 laptop initiative on student achievement in a 9th-12th grade upper middle class suburban New Jersey public school district was not statistically significant.

Summary

Two overarching research questions were addressed in this study to investigate the influence of a 1:1 laptop initiative on student academic achievement in a 9th-12th upper middle class suburban New Jersey public school district. Student performance on a variety of measures was used as a proxy for academic achievement, and Grade 8 NJASK scores were used to control for prior academic achievement before entering Grade 9.

The first research question sought to assess the influence of the use of a 1:1 laptop program on student academic achievement as it related to the New Jersey High School Proficiency Assessment in both English Language Arts and Math. The influence of a 1:1 laptop program was found not to be statistically significant on NJ HSPA ELA or PSAT achievement but was found to be statistically significant on NJ HSPA Math performance, indicating students not participating in a 1:1 laptop program tended to do better than students who did participate in a 1:1 laptop program. Therefore, Null Hypotheses 1 and 3 were retained, but Null Hypothesis 2 was rejected.

The second overarching research question sought to assess the influence of the use of a 1:1 laptop program on student academic achievement as it related to student school attendance and grade point average. Research Question 2/Null Hypothesis 4 was rejected, as the analysis showed that there was a significant difference in student GPA based on the use of a 1:1 laptop program for academic instructional purposes. Students who did not participate in a 1:1 laptop program tended to have a higher GPA than students who did participate in a 1:1 laptop program. Research Question 2/Null Hypothesis 5 was affirmed, as the analysis showed there was no statistical significance regarding the use of a 1:1 laptop program and student school attendance.

The following five null hypotheses were tested and either retained or rejected.

Null Hypothesis 1: There is no significant impact on a student's HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8). - Retained

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner and student prior achievement (i.e., NJASK 8). - Rejected

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8). - Retained

Null Hypothesis 4: There is no significant impact on a student's HS GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8). - Rejected

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8). – Retained

A more in-depth discussion of the findings takes place in Chapter V.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The ever-increasing use of technology as part of the teaching/learning process has been a component of the growth of the American school system. Whether it is the introduction of textbooks, early computer usage or other tools to facilitate learning, schools have always attempted to increase student learning through the use of technology (Saettler, 1990). With the increase in computing power, ubiquitous wireless access to the Internet, and falling costs, schools have been increasingly embracing the use of individually student-issued laptops for classroom use as part of 1:1 laptop programs. In 2009, this was quantified by the National Center for Educational Statistics, which noted that 97% of all teachers had computers in their classrooms. As another example of the growth of computer usage, in 2013 Harris Polling noted that 70% of middle school students reported using laptops for learning and that number grew to 75% at the high school level (Harris Interactive, 2013). As more and more school districts dedicate time and resources to integrate these programs into their practice, more research is necessary to measure the impact on student academic achievement.

This need was noted in 2008 by Dunleavy and Heinecke as they advocated for more rigorous studies that put special emphasis on the need for additional research on the impact of laptops being used with students on a 1:1 basis. While they noted that research had shown that laptops increase engagement, there were no studies that showed a connection between laptop usage and student achievement. Clearly, schools would benefit from research that sheds light on the connection between this type of technology usage and student achievement.

Purpose

The purpose of this quantitative, quasi-experimental, comparative design was to explore how much variance, if any, the implementation of a 1:1 laptop initiative has on student achievement. This study sought to determine the effect, if one exists, on student achievement that can be attributed to the widespread and comprehensive use of a 1:1 student laptop initiative at a suburban New Jersey high school. The results can be used by educators, school administrators, and policy makers to guide decisions regarding future 1:1 student laptop initiatives.

Organization of the Chapter

In this chapter, two research questions that were examined are reiterated and answered. The results are discussed succinctly and also in comparison to other related research on the topic. From the findings, conclusions are drawn and recommendations are made for current policy and practice. Additionally, recommendations for future research are suggested.

Research Questions and Answers

Research question 1: What impact, if any, does the implementation of a 1:1 laptop initiative have on student academic achievement as measured by standardized student achievement test scores; i.e., the New Jersey High School Proficiency Assessment for both Math and English Language Arts and PSAT scores when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 1: There is no significant impact on a student's HSPA Language Arts performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Answer: Null Hypothesis 1 was retained as evidenced by the results of the data analysis reported in Chapter IV. When controlling for prior academic achievement (NJASK 8 ELA), there was no statistically significant difference in student performance on the HSPA ELA based on whether the student participated in a 1:1 laptop initiative or did not participate.

An ANCOVA to determine significant differences on the 2014 HSPA ELA scores based on the main effect of 1:1 laptop usage was run. Propensity score matching was used to control for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education status, status as an English Language Learner, and student prior academic achievement. The use of an ANCOVA was necessary to help control for past performance. The estimated marginal means scores for the groups after the covariate was taken into consideration indicated that the difference was found not to be statistically significant.

According to this analysis, the use of a 1:1 laptop program for the purpose of academic instruction did not have a statistically significant effect on student academic performance as indicated by scores on state standardized tests.

Null Hypothesis 2: There is no significant impact on a student's HSPA Mathematics performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Answer: Based on the analysis, the null hypothesis for this research question was rejected. The use of a 1:1 laptop for the purpose of academic instruction had a statistically significant effect on the academic performance of those who participated.

In order to answer Research Question 1/Null Hypothesis 2, a simultaneous multiple regression analysis was conducted. The goal of this analysis was to determine the amount of influence 1:1 laptop participation, gender, special education status, attendance, and standardized test taking had on Grade 11 student performance on the 2014 NJ HSPA Math test. A multiple regression model was required since it was not possible to conduct an ANCOVA, which was the preferred analysis consistent with the analysis for answering Research Question 1/Null Hypothesis 1. The primary assumption for ANCOVA, the homogeneity of the regression slopes, was not satisfied during the preliminary analysis of the data, making ANCOVA a moot analytic procedure. Therefore, utilization of multiple regression analysis was appropriate.

To better control for the influence of the control variables on the dependent variable, a multiple regression model was performed. It was determined that four of the variables included in this model were statistically significant predictors of performance on the 2014 NJ HSPA Math test. Gender contributed to 1.6% of the variance, while special education status contributed to 5.89% of the variance. Along with those two variables, performance on the NJASK 8 standardized Math test was a significant predictor, contributing to 42% of the variance; and student participation in a 1:1 laptop program was a significant predictor and contributed to 2.7% of the variance.

According to this analysis, past academic performance on the NJASK 8 standardized Math test was the strongest predictor of academic performance on the 2014 NJ HSPA Math test. There was a positive relationship between the performance on these respective tests. As student performance increased on the NJASK 8 standardized Math test, performance on the 2014 NJ HSPA Math test did as well.

The use of a 1:1 laptop as part of one's academic instruction was also a predictor of performance on the 2014 NJ HSPA Math test. There was a negative relationship between the use of a 1:1 laptop as part of a student's academic program and his or her performance on the 2014 NJ HSPA Math test. Students who participated in a 1:1 laptop program generally performed lower than students who did not participate.

Null Hypothesis 3: There is no significant impact on a student's PSAT performance that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Answer: Based on this analysis, the null hypothesis for this research question was retained. The impact of a 1:1 laptop initiative on student achievement as it relates to PSAT performance was not a significant predictor of student performance when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education status, status as an English Language Learner, and student prior achievement.

An ANCOVA was used to answer this research question. The ANCOVA assessed whether statistically significant differences were found among students who had access to a 1:1 laptop program as part of their overall academic program as opposed to those who did not. As part of this analysis, it was determined that the difference between these two groups was not statistically significant. There was no significant difference in student performance on the PSAT based on whether the student participated in a 1:1 laptop program or did not participate when controlling for student performance on the NJASK 8 standardized test as the co-variate.

Research Question 2: What impact, if any, does a 1:1 laptop initiative have on in-school measures of performance, including, but not limited to, student grades and student attendance when controlling for gender, socioeconomic status, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8) through the implementation of propensity score matching sampling?

Null Hypothesis 4: There is no significant impact on a student's high school GPA that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Answer: Based on the analysis, the null hypothesis for this research question was rejected. A significant impact on student's high school GPA can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement.

An ANCOVA was run to assess the influence of a 1:1 laptop initiative on student academic performance as it relates to student grade point average. The ANCOVA revealed that estimated marginal means scores for the groups after the covariate of student attendance was taken into consideration was found to be statistically significant. It should be noted that the use of a 1:1 laptop program was inversely proportional to student grade point average. Based on the analysis, the use of a 1:1 laptop initiative had a negative impact on student grade point average.

Null Hypothesis 5: There is no significant impact on a student's attendance record that can be attributed to the use of a 1:1 laptop initiative when controlling for gender, socioeconomic status, grade point average, class attendance, ethnicity, special education classification, status as an English Language Learner, and student prior achievement (i.e., NJASK 8).

Answer: Based on the analysis, the null hypothesis for this research question was retained. The use of a 1:1 laptop as part of academic instruction was found not to be statistically significant as it relates to student attendance. An ANCOVA employed to complete the analysis and the estimated marginal means scores after the covariate of grade point average was taken into account was found not to be statistically significant and showed that student attendance was not affected by the use of a 1:1 laptop program for the purpose of academic instruction.

Measuring the impact of a 1:1 laptop program on academic achievement, especially when one considers the tremendous time and effort being spent on such initiatives, is essential as educators and policy makers allocate limited school resources. To complete the most effective and valid study of the impact of a 1:1 laptop initiative and to approximate, as best as possible, a randomized design methodology, propensity score matching (PSM) was used to pair like students from the sample high school with like students from the control high school. This enabled the researcher to better balance the various confounding variables and decrease the impact of selection bias that can occur in this type of study. The use of PSM has been effective across a wide variety of subject areas, including economics, social sciences, and health services research to help increase precision and reduce bias (D'Agostino, 1998). Propensity score matching, along with the analysis of variance, was used to explore the influence of a 1:1 laptop initiative, controlling for a variety of factors on student academic achievement in an upper middle class suburban New Jersey 9^{th}-12^{th} grade high school.

Conclusions and Discussion

The analysis revealed that the use of a 1:1 laptop program for the purpose of academic instruction has, for the most part, no statistical significance on the academic achievement of students who participate. Specifically, the lack of statistical significance was found to apply to student achievement on state standardized testing as it relates to English Language Arts, student PSAT performance, and student attendance. It is imperative to note that this research, while showing statistically significant results, had delimitations. The demographic scope of both the sample and control group were narrowed to the connection between 1:1 laptop usage and student achievement in two 9^{th}-12^{th} grade upper middle class suburban New Jersey public high schools, and that limited scope should give one pause before extrapolating the results beyond this study. Along those same lines, the size of the student populations was rather small (50 per group); a larger cohort would have helped to offset this size delimitation and strengthen the overall propensity score matches.

In the two instances in which there was statistical significance in achievement on standardized math tests and student grade point average (GPA), the impact of the 1:1 laptop usage negatively correlated with student achievement. In other words, the use of a laptop program showed statistical significance related to student standardized test performance and GPA for students who did not participate in a 1:1 laptop program.

The first statistically significant instance from the analyzed data focused on the impact of 1:1 laptop usage on student performance on a math-based state standardized test. The data analysis showed that student participation in a 1:1 laptop program was a significant predictor on the HSPA Math test. Laptop participation contributed to 2.7% of the variance in the regression model as was determined by squaring the value of the standardized beta-coefficient ($b = -.164$). The negative beta indicates that students who participated in 1:1 laptop programs tended to score lower on NJ HSPA Math. On average, they scored 8 points lower than those who did not participate in a 1:1 laptop program.

The second statistically significant instance from the analyzed data had to do with the impact of 1:1 laptop usage on student performance as it related to student grade point average. The mean GPA for students who did not participate in the laptop program was 3.542, and the mean 2015 GPA for students who did participate in the laptop program was 3.259. Of special note is that the statistical significance of these results showed that students who participated in a 1:1 laptop program had lower grade point averages than students who did not participate in such programs.

Of the statistically significant results from the data analysis, it is worthwhile to point out that both results correlated with negative performance on both a state-required math standardized test and student grade point average. These negative results indicate the need for further research and study.

However, caution must be exercised when drawing conclusions from the analysis of the data because certain variables must be considered. This includes the size of the sample population and that the population was drawn from upper middle class high schools in suburban New Jersey. These results may be generalized only to a similar population.

It is further important to note that the two rejected null hypotheses concerning student GPA and student performance on the NJHSPA could possibly be attributed to a variety of school-level factors. These include, but are not limited to, overall school size or the discrepancy in total student population between the two schools used in the study. It is worth noting that BHS's school population is approximately 55% of FHS's school population.

Further relating to the school population size concerns is the use and distribution of financial and human capital resources regarding the commitment to staff/professional development and the overall burden on school finances due to limited resources based on staff and student total population. School level factors should not be disregarded when it comes to the discussion and consideration of this study's two null hypotheses.

Previous research on this topic is split in this regard. There has been considerable disagreement among researchers who have explored the connection between the use of 1:1 laptops and student achievement. Some studies found that student performance is positively impacted (Gulek & Demirtas, 2005; Penuel, 2006), and yet there are others that found a negative impact (Inal, Kelleci & Canbulat, 2012; Penuel, 2006). As a compounding factor in this research, it should be noted that the majority of the studies centered on exploring the connection between 1:1 laptops and student achievement focus on the K-8 grade level. The split findings from the various research studies reinforce the idea that not only is more research needed but that the research should concern itself with student achievement as opposed to solely being about student engagement. Further, the research should be expanded to examine the impact of 1:1 laptops at the 9^{th}-12^{th} grade level.

In 2008, The Abell Foundation conducted a study that countered the results of this research. The Foundation's research examined the impact of three statewide 1:1 laptop programs—Maine, Michigan and Texas—and the ensuing effect of those programs on student learning experiences. When considering the broad impact on all three states, the study showed that 1:1 laptops served to increase student engagement as measured by student self-reported interest in school, attentiveness to in-class academic tasks, and overall interest in the learning process and served as a positive factor in helping students make positive behavior choices. These findings spoke to the classroom environmental impact of a 1:1 laptop program, and the findings from other studies do not dispute this. As with Penuel's 2006) and Cuban's (1986) work, the use of 1:1 laptop programs has been shown to increase student engagement. What has not been established via these studies is the impact on the educational growth of students who take part in 1:1 laptop programs.

Of the three states that were examined as part of the Abell Foundation's study, there were no statistically significant gains in the state assessment performance of students in both Maine and Michigan. These findings align with the results of this study. Of the states that showed an impact, Texas reported that, as with this research study, reading, social studies, writing and science scores on state tests had either no statistically significant effect or any impact was inconclusive. Contrary to the results of this study, Texas reported that greater access to a 1:1 laptop led to higher scores but did not comment on the statistical significance of those scores when taking other factors into account. The most important finding to take from the Abell Study was that there was no statistically significant connection, at least in the case of these three states, to show that traditional state test assessment increased as a result of a 1:1 laptop program.

A body of research also exists that examines the classroom impact of 1:1 laptops on a local level. The results of this study both agree and disagree with those findings. A study of 6th graders in Pleasanton, California, showed that participants in a 1:1 laptop program (25% of the grade level) reported higher test scores than students who did not have access to the same technology (Group, 2006). The primary data used for this finding were student grade point averages, and this finding runs contrary to the results of this study. Further as to that same finding, the Peace River North School District in western Canada adopted laptops to address gender-based discrepancies on district writing assessments. The study showed that after two years of 1:1 laptop usage, the gap had closed significantly, with boys drawing even with girls at 88% and 89% proficiency, respectively (Group, 2006).

While those last two examples speak to the academic benefits of 1:1 laptops, Fried (2008) reported that laptop usage, while increasing student involvement and interest, did not share a statistically significant connection to improving student academic achievement. Fried went on to share a concern that a lack of focus on technology integration into the classroom setting is proving a barrier to increased adoption and academic achievement.

The findings of this study, when looked at in the context of the larger research base, confirm that while research has spoken to the use of 1:1 laptops at the state, local, and higher education level and while there has been a broad variety of implementation types and research studies conducted, there is no clear consensus regarding the use of 1:1 laptops as part of the teaching/learning experience as it relates to academic achievement. It is essential that student achievement, as it relates to the use of 1:1 laptops in the classroom, be evaluated to better understand the impact of these initiatives on the student experience.

It should be noted that, while schools are primarily academic institutions, there are social and emotional aspects to the work that is performed inside their walls. As noted in this research study's literature review and cited research, the use of a 1:1 laptop program, as could be seen in the Peace River study as well as the Abell Foundation findings, does show that student engagement in school, as measured by interest in school and having a great sense of connection to classroom work, is positively affected by the use of a 1:1 laptop as part of classroom instruction. Schools should consider these impacts from the use of laptops and should avoid the implementation of 1:1 laptops if the sole goal is to improve academic achievement as measured primarily via grade point average and standardized test scores.

Recommendations for Administrative Policy and Practice

The findings from this study may be shared with school leaders to increase their understanding of the impact and efficiency of introducing 1:1 laptop programs into the day-to-day lives of students. The dearth of research specifically examining the academic impact of 1:1 laptop programs, especially in the face of increasing adoption by school districts, should give school districts the opportunity to pause before dedicating both time and fiscal resources to 1:1 laptop programs. As school budgets tighten and resources become stretched further and further, the cost of acquiring the hardware in the form of a laptop, the software that is necessary to use the laptop in the classroom, and the professional development and training of instructors will be significant factors in measuring the return on the investment of a 1:1 laptop initiative. One may ask if the potential cost of a 1:1 laptop program is worth it, while recognizing that all schools already dedicate money to technology purchasing and training. In making the leap to a 1:1 program, especially as costs drop and implementation in neighboring districts grows, administrators and policy makers should give strong consideration to whether the development of a 1:1 program is a worthwhile endeavor. The important question that school districts should ask is what they want to positively achieve via the use of a 1:1 laptop program for the purpose of academic instruction.

This study, especially with its narrow scope and delimitations, should not be interpreted as being conclusive in its findings but should rather be viewed as another piece of scholarship that educational leaders and policy makers can use when assessing the liabilities and benefits of 1:1 laptop programs. District leaders are encouraged to investigate the growing body of research regarding these programs and to look beyond the research studies that speak to the social benefit of laptops but do not pay enough attention to their academic impact (Penuel, 2006).

In addition, district leaders should look at the implementation of a 1:1 laptop program in the context of the larger curriculum and teaching/learning practices in their districts. The rush to adopt technology as a “silver bullet” to solve a wide swath of problems has been present in education for far too long, and doing so will only lead to a loss of fiscal resources, frustrated teachers, and organization inertia (Kerr, 1991). This, along with the work of Cuban (1986), reinforces the idea that any administrative recommendations for policy and practice take place inside the larger context of teaching and learning. It would be foolhardy for a district leader to draw a singular conclusion from any research study that supports the idea that a 1:1 laptop program, offered in isolation and with little to no regard for the “bigger picture” of a school’s work, could lead to substantive and effective change.

It is also recommended that policy makers and district leaders collect data and analyze their own experiences with 1:1 laptop programs. Enough of these programs are being adopted locally, regionally, and nationally that a “critical mass” of districts would benefit from a research-based analysis of the benefits and liabilities of these programs. Blindly moving forward with 1:1 laptop adoptions would create a repeat of the same pattern of technology usage which is then summarily discarded after the “bright, shiny moment” fades (Scott, 1992.)

Recommendations for Future Research

Research on the academic impact of 1:1 laptop programs, while it continues to grow, is limited and the results have been inconclusive. This study offers empirical evidence to add to the existing body of research, and yet it must be recognized that a single study, especially one of limited scope and size, should not be seen as a definitive source for all answers. Additional studies on this topic, especially with larger cohorts and greater access to randomized sampling, could assist an analysis within the existing body of research of the impact of a 1:1 laptop program.

There are many questions that surround this topic, and it is not possible for a single study to be definitive, especially one that was limited to two high schools in a very narrow demographic and used limited achievement data. Recommendations for future research include the following:

1. Replicate the study with data from additional years and expand the scope of the study to include a broader demographic and socioeconomic cross-section of students who participate in 1:1 laptop programs. The size of the study and the narrow demographic sample can certainly be enlarged and should involve all grade levels and/or all student/community demographic levels.
2. Design a study that expands the data sampling to a broader range of information so that the impact of a 1:1 laptop initiative can be assessed across a wider variety of student experience. This could include grades on individual classes, scores on other standardized tests aside from the SAT, PSAT and state standardized tests, and teacher feedback on student academic performance.
3. Upon designing a future study on the influence and/or effect of a 1:1 laptop program on student academic achievement and efficacy, have that study take into

account the influence of school level factors based upon the "nesting effect" of students attending school within specific types of learning communities.

4. Design a qualitative study investigating the different types of academic impact that a 1:1 laptop program has on student performance and school experience. A qualitative study would act as an excellent supplement to the quantitative nature of this study.
5. Conduct a study that measures not only the academic impact of a 1:1 laptop program but also the classroom activities and curriculum decisions that most substantially impact the academic experience of students.
6. Design a study that focuses on best practices of 1:1 laptop usage to help identify the classroom usage and activities that create the most effective classroom setting to best take advantage of the potential of this type of learning environment.

Conclusion

The ongoing adoption and use of technology in the classroom has been ever-present in classrooms from the beginning of organized education. The results of this study on the impact of a 1:1 laptop program on student academic achievement serve to reinforce that further research, across a wide variety of areas, is necessary to ensure that the use of laptops represent the best use of time, resources, and teacher classroom choices. The inconsistent results of the various studies on this topic and the need to continue to investigate this topic further reinforce the need to continue to question the impact of 1:1 laptop programs. Questions still remain on the effectiveness of the widespread use of 1:1 laptop programs, and additional research is required to draw conclusions regarding the impact on the student learning experience.

It is important to place the use of laptops into the larger picture of ongoing efforts to offer our students greater and greater access to the world around them. If one envisions a laptop as not just a machine but rather as a gateway to all of the information—the good, the bad, the true, and the false—in the world and then thinks of the incredible responsibility of helping our students navigate their personal search for truth, the use of a 1:1 laptop initiative makes complete sense. School is much more than state test scores or grade point averages; and while those things are important, school is about broadening the horizons of our students while offering them the chance to do so under our guidance and assistance. The implementation of 1:1 laptop programs, when viewed this way, clearly has incredible potential to bring our students experiences that transcend the four walls of their classroom.

It would be foolhardy to think that a 1:1 laptop by itself will address the challenges, but a laptop in the right hands and under the guidance of a well-trained, prepared, and motivated teacher has the capacity to play its own small role in helping to change the lives of our students. Yes, more research is needed; but as that takes place, classrooms will continue to make good use of laptops as tools to help students grow.

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Appendix A: Request Letter to Conduct Research

EMERSON BOARD OF EDUCATION

Brian P. Gatens
Superintendent of Schools
bgatens@emersonschools.org

Philip H. Nisonoff, Ed.D.
Asst. Superintendent of Schools/S.B.A.
phnisonoff@emersonschools.org

May 1, 2017

Dear [redacted]

As a doctoral candidate at Seton Hall University, I am conducting research as part of the requirements for the fulfillment of the Ed.D. degree program. The title of my research project is "The Impact of a 1:1 Laptop Initiative on Student Achievement in an Upper Middle Class Suburban New Jersey Public School District," and the purpose of my research is to better understand the impact of these devices on student academic achievement.

I am writing to request your permission to use de-identified and anonymous student data from the class of 2015 as it relates to standardized test achievement and other student school information, including grade point average, attendance and socioeconomic status. Per the Family Educational Rights and Privacy Act (FERPA) 34CFR Part 99.31 (A)(6), this data can be released to me via the exception that covers the following:

> (6)(i) The disclosure is to organizations conducting studies for, or on behalf of, educational agencies or institutions to: (C) Improve instruction.

Pursuant to the exception found in FERPA, this research will require NO direct contact with students, nor will the identity of the students be known to anyone involved with this study at any time. If permission is received to use this data, it will be supplied already de-identified. All data will be managed and secured using all applicable data management strategies. Following the data analysis, all identifiable records will be destroyed in accordance with said regulations.

Thank you for considering my request. If you choose to grant permission, please furnish me with a letter to the same, and we can talk further regarding the logistics of data transfer.

Sincerely,

Brian P. Gatens
Superintendent of Schools

EMERSON BOARD OF EDUCATION

Brian P. Gatens
Superintendent of Schools
bgatens@emersonschools.org

Philip H. Nisonoff, Ed.D.
Asst. Superintendent of Schools/S.B.A.
pnisonoff@emersonschools.org

May 1, 2017

Dear [redacted]

As a doctoral candidate at Seton Hall University, I am conducting research as part of the requirements for the fulfillment of the Ed.D. degree program. The title of my research project is "The Impact of a 1:1 Laptop Initiative on Student Achievement in an Upper Middle Class Suburban New Jersey Public School District," and the purpose of my research is to better understand the impact of these devices on student academic achievement.

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Thank you for considering my request. If you choose to grant permission, please furnish me with a letter to the same, and we can talk further regarding the logistics of data transfer.

Sincerely,

Brian P. Gatens
Superintendent of Schools

Appendix B: Permission to Conduct Research

[redacted]

OFFICE OF THE SUPERINTENDENT

[redacted]
SUPERINTENDENT OF SCHOOLS

[redacted]

SCHOOL PERMISSION TO CONDUCT RESEARCH

May 2, 2017

Dear Seton Hall University Institutional Review Board:

The purpose of this letter is to inform you that Brian P. Gatens has received permission to use de-identified, anonymous student data for the purpose of data analysis for the research study titled "The Impact of a 1:1 Laptop Initiative on Student Achievement in an Upper Middle Class Suburban New Jersey Public School District."

It is recognized that this data can be released for the purpose of research and is being granted under the following exception to the Family Educational Rights and Privacy Act (FERPA) 34CFR Part 99.31 (A)(6), this data can be released as it covers the following:

(6)(i) The disclosure is to organizations conducting studies for, or on behalf of, educational agencies or institutions to: (C) Improve instruction.

It is understood that confidentiality as to the use of the anonymous student data will be maintained at all times, and that all relevant data will continue to remain de-identified and secured using all appropriate data management strategies. It is further understood that the data will be destroyed at the termination of the research study.

Sincerely,

[redacted]

Superintendent of Schools

[redacted]

[redacted]
Superintendent

SCHOOL PERMISSION TO CONDUCT RESEARCH

May 2, 2017

Dear Seton Hall University Institutional Review Board:

The purpose of this letter is to inform you that Brian P. Gatens has received permission to use de-identified, anonymous student data for the purpose of data analysis for the research study titled "The Impact of a 1:1 Laptop Initiative on Student Achievement in an Upper Middle Class Suburban New Jersey Public School District."

It is recognized that this data can be released for the purpose of research and is being granted under the following exception to the Family Educational Rights and Privacy Act (FERPA) 34CFR Part 99.31 (A)(6), this data can be released as it covers the following:

> (6)(i) The disclosure is to organizations conducting studies for, or on behalf of, educational agencies or institutions to: (C) Improve instruction.

It is understood that confidentiality as to the use of the anonymous student data will be maintained at all times, and that all relevant data will continue to remain de-identified and secured using all appropriate data management strategies. It is further understood that the data will be destroyed at the termination of the research study.

Sincerely yours,

[redacted]

Superintendent of Schools

The [redacted] will utilize the student learning standards to promote academic excellence and foster self-esteem in a dynamic, caring environment and will prepare students to be life-long learners and contributors in an evolving and ever-changing world.