1:1 LAPTOPS IN EDUCATION AND ACHIEVEMENT TEST RESULTS IN ONE RURAL HIGH SCHOOL

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ABSTRACT

The purpose of the study was to explore the relationship between a 1:1 laptop program and the achievement test results for the Ohio Graduation Tests (OGT). Two cohorts were examined (*N*=193): 1. Tenth graders who took the OGT subtests in Reading, Writing, Math, Science, and Social Studies in 2014 (*n*=109) and who had received traditional instruction and 2. Tenth graders who were given individual laptops and eTexts to use at school and at home, and who took the same OGT tests in 2015 (*n*=84). A Chi Square statistical assessment was conducted to compare student performance. No statistical difference was evident for overall passage rates when comparing the two cohorts. For the laptop cohort, there was no statistical difference in the expected counts for the subject areas of Writing, Science, and Social Studies. For Reading, laptop cohort scores reflect a trend, with scores moving upward into the Accelerated performance category. Math scores showed significantly more scores falling in the highest performance category of Advanced in comparison to what was expected. Similarly, when looking at the economically disadvantaged subgroup within the laptop cohort (*n*=29), a positive and significant difference from what was expected occurred within the Advanced category for Math, while a trend toward significance for improved performance occurred for Reading scores. The potential for significant gains in student achievement is evident. Additional longitudinal research is warranted to better understand the significance of impact as pedagogical practices develop following initial implementation and considering contextual factors.

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CHAPTER I

THE PROBLEM

Introduction

The use of computer technologies with the intent of improving efficiency and/or the quality of services and products has grown to permeate nearly every industry known to modern society. This includes areas of government, military, medicine, banking, sports, farming, marketing and sales, news media, entertainment, and even social interaction. Over the past 30 years, education has struggled to keep pace with advancing technologies (Marcinek, 2015). Early on, computer labs were added to schools and teachers were given desktop computers. With the assistance of federal and state funding programs, many classrooms in Ohio were equipped with a handful of student computers.

As wireless technologies improved and with the aim of improving efficiency and quality of teaching and learning, more schools are now looking to bring the computer and all of the resources of the Internet to each and every student. This access for all movement saw the birth of the 1:1 (one-to-one) laptop program. Sauers and McLeod (2012) define the 1:1 laptop program as one that "…provides a take-home laptop computer for every student within some grade span of the school system" (p. 2) The authors add that providing computer-based learning for everyone, anytime, and anywhere is a relatively new approach to education. This is a significant paradigm shift in how learning is experienced. Many have compared the Internet and computer to the printing press and book. Both were monumental in changing how knowledge and information are accessed and shared.

Statement of the Problem

Considering the significant investment associated with purchasing computers and electronic textbooks for each student in addition to the mandate to improve education and raise the achievement levels of all students, schools find themselves at a critical juncture within the history of education reform (Weston & Bain, 2010). Two important questions pertaining to reform efforts confront today's schools. First - can we justify the use of limited resources to provide and sustain a program that has limited evidence to suggest effectiveness (James, 2010)? And second, can we afford to stay with the status quo (November, 2013)?

The purpose of this study is to investigate the relationship between a 1:1 laptop program and achievement test scores as reflected by the Ohio Graduation Test (OGT) in one rural high school district in northeast Ohio. This study will compare the 2014 OGT tenth grade student scores to the 2015 OGT tenth grade student scores. Students who took the OGT in 2014 engaged in traditional teaching and learning practices while the 2015 students were participants in the 1:1 laptop program, which included providing laptops and electronic textbooks for each student.

Assumptions Underlying the Study

A number of assumptions are inherent in this study. First, the researcher assumes that the participant sample includes only students who attended classes at this high school. Of the sample, those who took the Ohio Graduation Test in 2014 attended traditional classroom, prior to the implementation of the 1:1 laptop program. Those who took the Ohio Graduation Test in 2015 participated in the newly implemented 1:1 laptop program. As this sample includes all students at this school who took the OGT in 2014 and 2015, we can assume that this comparison of participants and non-participants accurately represents the larger student body of this high school. Second, as strict protocols and procedures were used for administering and securing test instruments, it is assumed that participants did not cheat nor was there and advantage one group had over the other. Third, it is assumed that the scores reported back by the Ohio Department of Education accurately reflect student achievement in the content areas for which students are assessed by the OGT. And while the validity to which the OGT tests what is learned in the classroom is dependent upon what is taught in each classroom, both the 2014 and 2015 groups were tested over the same standards, making for a fair comparison of the results between the two. As such, the researcher assumes that the instrument used in assessing student achievement was consistent for both administrations of the OGT.

General Research Hypotheses

Prior research on the topic of 1:1 laptop programs in schools suggests that achievement gains can be realized in association with laptop programs. The research also shows that in many cases, achievement gains do not materialize (Goodwin, 2011; Hu, 2007; Vascellaro, 2006). Some programs report an increase in student engagement while others find the devices to be a distraction that fosters behavior problems (Dunleavy, Dexter, & Heincke, (2007). Where successful integration yields positive results, those who show the greatest achievement gains are among two at-risk groups of students: economically disadvantaged students and special education students (Zheng, Warschauer, Hwang, & Collins, 2014). And among the subject areas assessed, Reading and Writing achievement gains have typically been the most significant and most consistent as compared with Math, Science, and Social Studies. Still, under the right conditions, achievement gains have been found across all five subject areas tested. With all of this in mind, this study will challenge the following three general research hypotheses:

1. There is a relationship between the initiation of the 1:1 laptop program (laptops and electronic textbooks for each student) and the Ohio Graduation Test gains (Holcomb, 2009, Beebel & Kay, 2010; Sauer & McLeod, 2012).
2. There is a relationship between the 1:1 laptop program (laptops and electronic textbooks for each student) and content area subtest scores (Argueta, Huff, & Tingen, 2011; Buzzetto-More & Alade, 2006; Sauers & Mcleod, 2012).
3. A relationship exists between OGT subtest scores for content areas, predicting achievement test gains for the at-risk population of students with an economic disadvantage (Zheng, Warschauer, Hwang, &Collins, 2014).

Significance of the Study

The study of 1:1 laptop programs in schools is relatively new, with most research efforts in this arena taking place within the past twenty years. As discussed in chapter 2, findings are mixed regarding the impact these programs might be having on student achievement. Some programs have thrived while others have collapsed. Researchers point to a number of possible reasons for successes and failures, including how the programs are implemented in schools and how the technology is integrated in classrooms. Teacher preparation and community engagement seem to be closely related to successful programs.

Two points of interest appear to be absent from this emerging debate over the effectiveness of 1:1 programs. First, there appears to be little or no discussion on the topic of electronic textbooks as key program components. There are studies which evaluate specific software programs used by students in laptop programs. But, to hand students laptops to carry around while continuing to use traditional textbooks seems to be an approach that assumes the device itself is going to magically help students learn. It also removes the need for the teacher to be engaged in the classroom integration of the laptops. Further, by only giving students laptops we forfeit the potential inherent in the interactive online textbooks that facilitate differentiation, communication, and collaboration. Laptop programs in themselves may look good in the newspaper, but without including electronic textbooks, are we merely handing students expensive toys? This study will examine a 1:1 laptop program where electronic textbooks are provided in each of the subject courses assessed by the state OGT.

1:1 laptop programs arguably advance the potential for developing 21st Century skills, which include communication and collaboration, critical thinking and problem-solving, creativity and innovation, and the rapidly evolving notion of technology literacy. The current measuring stick used to evaluate the effectiveness of schools, however, is specific to student achievement as reflected by standardized state test scores. Some schools have found success with their laptop programs showing improved test scores, while others have failed to produce any recognizable gain in student achievement. School funding concerns are a very real part of our current environment. Considering the unquestionable expense associated with purchasing laptops for every student, 1:1 laptop programs may very well be the our most expensive educational experiment to date. Still, more and more schools are initiating or considering a move toward implementing a 1:1 laptop program. There is a critical need to better understand the impact these programs might be having on student achievement (Hansen et al., 2012; Lindroth & Bergquist, 2010). “The reasons . . . remain, as of yet, largely unanswered. However, given the relevance to strategic investments in the public interest, further research in the area is of utmost importance” (Sauers & McLeod, 2012, p. 84). This study was conducted to add a voice to the growing discussion about the effectiveness of these programs.

Delimitations

Ohio Graduation Test scores were used in this study to investigate the relationship between a 1:1 laptop program and student achievement. The advantage in using the OGT is that these assessments are standards-based and can be assumed consistent from year to year. As they are scored independently by the state, the potential for local bias is removed. Still, there are a number of delimitations. First, many things learned in the traditional classroom and with laptop program are not assessed on the OGT. Simply put, this study is delimited by achievement measures as they are defined by the Ohio Graduation Tests. Second, while the sample population of 2014 and 2015 tenth graders is representative of this school, this school lacks diversity, making it difficult to generalize beyond the scope of the school. Students considered in a racial or ethnic minority, for example, make up less than one percent of this school’s population.

Third, a small number of the student scores were removed from the sample, as these students were enrolled in special programs outside of the school and as such did not participate in either the traditional class instruction or the 1:1 laptop program. The scores of three students were enrolled in online school courses and did not physically attend class at the school begin studied. Two other students attended alternative placements at county schools. These scores were also omitted from the study sample. Similarly, the scores of two students were removed from the original sample because they had moved into the district after the first semester of their tenth grade year. Their OGT scores were removed because they were more of a reflection of a previous school experience than of the school for which this study is conducted.

Next, we must recognize that this study is delimited in the scope of the laptop program. While students at other grade levels participate in the 1:1 laptop program, it is only tenth grades who take the Ohio graduation test. As a result, we are focusing only on tenth grade achievement in relationship to the laptop program.

And finally, it is also important to note that this study is delimited by tenure of the 1:1 laptop program at this school. Tenth graders in the laptop program were tested mid-way through their second year of having laptops and eTexts. And for their tenth grade teachers, this was their first year using the devices and electronic resources for instruction. As such, this study is delimited by the lack of program longevity.

Definitions and Operational Terms

1:1 Laptop Program - There are many variations on the device and program employed by schools engaging 1:1 computing. For the purpose of this study, the 1:1 laptop program is one where every student in the program is given a laptop to use at school and at home (Sauers and McLeod, 2012). As part of this school's program, each student is also provided access to Internet-based electronic textbooks for the following courses: English (Reading and Writing), Math, Science, and Social Studies.

Achievement Gain – As opposed to growth, which looks for improved achievement test scores for the same group of students, achievement gains herein refers to improved achievement test scores when comparing two different groups of students (Abbott, 2014b). For the purposes of this study, achievement gains reflect the measured difference between 2015 and 2014 scores on the OGT, comparing the tenth graders in the laptop program to tenth graders the year before the implementation of the laptop program. Two different groups of students are compared.

Achievement Test Scores - Each student taking the Ohio Graduation Test receives a normed score (based on the scores of all Ohio tenth graders) for each of the five subject area tests Reading, Writing, Math, Science, and Social Studies. A passing scaled score for each of these tests is set at 400. "Because raw scores may not be comparable across test administrations, they are converted to scaled scores for reporting purposes. Since all test administrations within the same subject are equated to the same scale, scaled scores allow comparisons between different students taking different administrations of the test" (Ohio Department of Education, 2014, p. 4).

At-risk Students - "The term at-risk is often used to describe students or groups of students who are considered to have a higher probability of failing academically or dropping out of school. The term may be applied to students who face circumstances that could jeopardize their ability to complete school… [and] …in certain technical, academic, and policy contexts—such as when federal or state agencies delineate 'at-risk categories' to determine which students will receive specialized educational services, for example—the term is usually used in a precise and clearly defined manner. For example, states, districts, research studies, and organizations may create at-risk definitions that can encompass a broad range of specific student characteristics, such as the following: Physical disabilities and learning disabilities, prolonged or persistent health issues, habitual truancy, incarceration history, or adjudicated delinquency, family welfare or marital status, parental educational attainment, income levels, employment status, or immigration status, households in which the primary language spoken is not English" (Abbott, 2014a, p.1). For this study, at-risk students are defined as those who are 'at-risk' of not passing the Ohio Graduation Test. The sub-population of at-risk students examined in this study are those who are economically disadvantaged as determined by their eligibility to receive free or reduced pricing for school lunches.

Content Areas - "Content areas are also known as subjects; e.g., reading, mathematics, writing, science, and social studies" (Ohio Department of Education, 2014, p. 4).

Economic Disadvantage - "Students who are known to be eligible to receive free or reduced-price lunches; a program through the United States Department of Agriculture (U.S.D.A) National School Lunch Program. Eligibility for free or reduced-price lunch can be determined through a variety of methods including the electronic direct certification process or completion by a parent or guardian of a free and reduced-price lunch application. A student with an approved application on file for a free or reduced-price lunch is qualified to be reported to ODE [Ohio Department of Education] as economically disadvantaged" (Ohio Department of Education, 2011a, p. 1). This same criteria is used by the state of Ohio in determining economic disadvantage for purposes assessment reporting.

Electronic Textbooks – The definition of the electronic textbook (eText) is constantly evolving as interactive components emerge in addition to the fundamental on-screen digital format most directly associated with eTexts. More than a mere digital copy of the traditional hardbound printed paper textbook, electronic textbooks (eTexts) are becoming more and more interactive, individualize for ability (such as reading level), provide assessment with instant feedback for students and data for teachers. They also come with various links to supporting videos, activities, and supplemental resources (Kim, 2015).

Nonparticipants (antonym) - "other than…a person who is involved in an activity or event: a person who a person who does not participate" (Meriam-Webster, 2015, p. 1). Students who took the Ohio Graduation Test in March of 2014 received traditional instruction (prior to the laptop program implementation) and as such did not participate in the 1:1 laptop program. In this study, nonparticipants are the "no laptop cohort."

Ohio Graduation Tests (OGT) – "The Ohio Graduation Tests (OGT) are a key part of Ohio's education reform to establish an aligned system of standards, assessments and accountability for Ohio schools. The testing requirements were established by the Ohio General Assembly in 2001 based on recommendations by the Governor's Commission for Student Success. Tests in reading, writing, mathematics, science, and social studies make up the OGT" (Ohio Department of Education, 2011b, p. 1). Since their establishment by the Ohio General Assembly in 2001 and through the 2014-15 school year, the OGT has been administered during the tenth grade year of high school as a requirement for graduation.

Participants – "a person who is involved in an activity or event : a person who participates in an activity or event (Meriam-Webster, 2015, p. 1). Participants in the 1:1 laptop program, also referred to as the treatment group, are those students who took the Ohio Graduation Test in March of 2015. In this study, nonparticipants are the "laptop cohort."

Total OGT Score - For the purposes of this study, a total OGT score for each student is derived by combining the five subject area achievement test scores. A student's total score is the sum of his/her Reading, Writing, Math, Science, and Social Studies subtest scores. Total scores were calculated by the researcher, as results from the Ohio Graduation Test do not provide any type of a composite or total score.

Summary

The rapidly increasing role of technology integration in schools has become problematic for several reasons. First, it requires major changes in how teaching and learning are delivered. Schools are complex social constructs that historically have been slow to change. Secondly, the cost associated with providing these technologies can put tremendous pressure on schools to produce immediate results that reflect the ultimate goal of improving education. Third, while state achievement tests are limited by a narrow definition of achievement, the state tests are the accepted standard by which student achievement and school performance are defined.

Still, regardless of trending technologies, our desire to improve schools, or the barriers associated with education reform, we need to know that what we are doing with students is accomplishing the goals we have set. It is the intent of this study to provide a glimpse into the impact a 1:1 laptop program might be having on student achievement in one rural Ohio high school. To provide a context on which this study will build, the following chapter summarizes and synthesizes the current research on the topic of 1:1 laptop programs in schools. As studies have shown, conflicting results are abundant. Many questions are yet to be answered in this evolving conversation.

CHAPTER II

LITERATURE REVIEW

Defining the 1:1 Laptop Program

One-to-one (1:1) school laptop programs have been growing steadily in the United States and around the world with the aim of transforming education (Abell Foundation, 2008; Bebell & Kay, 2010; Hansen et al., 2012; Hayes & Greaves, 2008; Inan & Lowther, 2010; Penuel, 2006; Weston & Bain, 2010; Zucker & Light, 2009). In the United States, initiatives hope to prepare students to be college and career ready (Warschauer, 2007; Weston & Bain, 2010; Corn et al., 2012). Numerous authors have indicated an array of reasons for the emergence of the 1:1 laptop movement. Inan and Lowther (2010) cited three general goals: to prepare students for the workforce, to improve skill and achievement, and to improve instruction. And while implementation models and degrees of success and failure vary greatly among 1:1 programs, most involved in the process generally agree that by definition, 1:1 programs provide one wireless digital computing device for each student and teacher, with software and Internet access, and encompassing at least a particular grade level within a school (Corn et al., 2012; Penuel, 2006; Sauers & McLeod, 2012). In essence, 1:1 laptop programs are attempting to do more to individualize learning opportunities while simultaneously maximizing the achievement capacity for all - more so than any other educational reform to date.

Background / Context and Overview

The Evolution of the Computer

The first commercial use of a computer came about out of necessity, when the United States government found itself hampered in its attempts to tabulate an exploding population for the census of 1880 (Zimmerman, 2012). Though relatively new in the education arena, 1:1 computing in concept traces its earlier roots in business and industry (Fleischer, 2012), most notably - the devices manufactured by the International Business Machines company (IBM). This earliest computer use for business purposes, explained Wright, Fisher, and Joyce (2007), combined the telegram with the tabulation machine in a way that allowed information to flow freely, overcoming boundaries and other geographic restrictions. With this union in mind, the late 19th century tabulating device combined with the telegram can be seen as a precursor to the modern computer and its marriage to the Internet. A leading visionary of technology in contemporary education, Alan November (2013), asserted that today's students need to have 24- hour access to the Internet. For schools, the aim of 1:1 programs is to provide computer access for anytime, anywhere learning (Cavus & Al-Momani, 2011; Ian & Lowther, 2010), likewise overcoming boundaries and other restrictions of place and time.

Ubiquitous Technologies

Initially referred to as ubiquitous computing, Weiser (1991) envisioned technologies of the future as so commonplace that they are unnoticeable: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (p. 94). In this regard, Swan, Van 'T Hooft, Kratcoski, and Schenker (2007) point to the pen, pencil, paper and eraser as examples of ubiquitous technologies. Ultimately, the great hope is that when the use of computers becomes as fundamental to learning as the paper and pencil, the long-awaited next major advancements in education will emerge. Thirty years ago, Bork (1985a) pointed out that in the United States, there were on average six computers in each school. This author went on to predict that with the emerging trends, computers would soon have a historically significant impact on education:

> We stand at the beginning of a major revolution in the way people learn … We are moving rapidly toward a future when computers will comprise the dominant delivery system in education for almost all age levels and in most subject areas. Not since the invention of the printing press has a technological device borne such implications for the learning process. (in Lowther, Ross, & Morrison, G. (2003), p. 23)

Authors such as Bork (1985a) may have overestimated the speed at which change takes place in education, but the impact of computers in schools is an unquestionable reality today. Weston and Baine (2010) echo Bork (1985a), suggesting that 1:1 laptop programs will likely do more to change schools than any other reform effort of the past.

In agreement with November (2013) regarding Internet access as an educational imperative, Papert (1980) went even further in arguing that to make significant changes in our schools, every student must have a computer. If November, Bork, and Weston and Bain are correct, Papert (1980) asks us to imagine having only five pencils in a classroom that are to be shared by students taking turns. In this analogy we find the challenge of 21st century teaching and learning when students have to share computers. Interestingly enough, Papert (1980) saw this challenge emerging 25 years ago.

Purpose/Significance of Laptops in Schools

What, then, is the purpose of the laptop computer in the classroom and what makes it as significantly fundamental to learning as the pencil? Zucker and Light (2009) suggested that because computers are all-purpose machines, they are different than other technologies used in schools. A laptop is a library, a tool for communication and collaboration, a way to create, record, and share knowledge, and as Buzzetto-More and Alade (2006) added, an effective medium for assessment and intervention. This is not to mention the inherent word processing and Internet search capabilities. Moreover, Battro (2013) argued that our traditional computer lab is an obsolete model, whereas an individual laptop is mobile and without time or place restrictions. This, added Cavus (2011), makes for a more flexible and interactive learning experience.

Education: A People Business

Education is a living, breathing, dynamic construct. Much like other social sciences, it evolves alongside the people and politics it serves. Education is perhaps the quintessential example of a people business (Sturtevant, 2014). Its manufacturers (teachers) are people. The raw materials (students) are people. The product (the educated) and the consumers who invest in and direct education (societies and their governments) are all people. And, as people evolve, so do their needs and demands on education. Technology, on the other hand, is but a tool (Inan & Lowther, 2010), not unlike a book, a piece of paper, or a pencil; a means to an end . . . a vehicle for delivering the product.

As Tyack and Cuban (1995) wrote in *Tinkering Toward Utopia*, while the evolution of education and its initiatives historically swings like a pendulum between philosophical extremes, schools do in effect slowly but surely move in a forward direction. Moving forward, however, rarely happens by accident. Progress occurs most often when we commit thoughtful attention to understanding what works and what does not work, constantly refocusing our efforts toward the evolving mission. We challenge our assumptions as we build on what we have come to know with a collective vision of where we want to be. For the purpose of this paper, we begin with what we know about technology, specifically 1:1 laptop programs and the roles they are playing in our efforts to move education forward.

Benefits and Cautions With 1:1 Programs

Education is called to answer the charge of many goals, most of which are ultimately measured by the various test scores reflecting the degrees of academic achievement of students. Other objectives of education include 21st Century skills, such as abilities to effectively use information and communication technologies (ICT), abstract reasoning, collaboration and problem-solving skills. It is also a goal that schools engage and motivate students to take ownership of their learning as reflected in on-task behavior, discipline/conduct, and attendance. While indirectly connected to content mastery, these additional aims arguably contribute to the ultimate goal of academic achievement. And as such, these goals of education are purported to benefit from 1:1 laptop programs.

Twenty-first Century Learning

Beginning with 21st century skills, it is significant to point out that no author argues against the value of this modern educational construct. Still, studies relative to the progress schools are making in the area of 21st century learning are few. In fact, most

1:1 laptop studies try to identify correlations between the 1:1 programs and standardized test scores, assessments which do not effectively measure 21st Century skills (Canuel, 2010). Studies that do measure these more elusive contemporary aptitudes and their relationship to 1:1 programs report significant growth in correlation to laptop programs (Lei & Zhao, 2008; Mo, Swinnen, Zhang, Yi, & Qu, 2013; Spekto-Levyr & Granot-Gilat, 2012). And unlike other measures impacted by 1:1 programs (such as student motivation), no author has argued counter to the positive findings relative to information and communication technology skills gained with 1:1 laptop programs.

Some researchers assert that other higher level thinking skills neglected by most standardized assessments are also strengthened as a result of each student having a personal laptop. These other 21st century skills include creativity, organizational skills and self-management, independence and collaboration skills, and critical thinking and problem-solving skills (Cristia, 2012; Serin, 2011; Spekto-Levyr & Granot-Gilat, 2012). Similarly, the development of abstract reasoning skills associated with academic performance in multiple subject areas also appears to be positively associated with 1:1 programs (Beebel & Kay, 2010; Hansen et al., 2012; Serin, 2011). It is ironic that while neglected by most standardized assessments, 21st century skills may in fact be influenced more by the 21st century tools available with 1:1 laptop programs than are the achievement measures most commonly studied in relation to standardized test scores.

Student Engagement

Beyond 21st century skills, a number of studies suggest that 1:1 laptop programs have a positive impact on student engagement. This includes correlations between these programs and data measuring on-task behaviors, classroom conduct, discipline referrals, and attendance at school. Improved student motivation is a common theme among 1:1 laptop studies (Bebell & Kay, 2010; Warschauer, 2007). But Hatakka, Andersson, and Grönlund (2013) warned that while education can be more fun with laptops, the fun can be more about social media than learning. Argueta et al. (2011) found mixed results for student motivation and discipline among different programs. While at-risk students appeared to have improved motivation with laptop programs in Maine, teachers in studies conducted in Virginia and Texas saw no improvements for student engagement and in some cases saw an increase in discipline problems associated with off-task behaviors. Mixed results pertaining to engagement were similarly found by Addis and Faulk (2010). And as Hu (2007) reported, parent support eroded when students were found to be misusing their laptops. On the contrary, behavior problems in select elementary classes dropped significantly (Canuel, 2010). And while student motivation and engagement were shown to improve in one college engineering course, the notion of better active learning did not appear to produce improved grades (Luke, Dunn, and Christie, 2017).

Because the use of laptops in the classroom becomes ubiquitous, it is often hard to determine the difference between good and bad use (Lindroth & Bergquist, 2010). A number of researchers point to the potential distractions posed by laptops. Guimarães, Ribeiro, Echeveste, and Jacques, (2013), for example, found that middle school students who were surveyed valued their laptops more for communication and games than for learning. Looking at the use of laptops in a large college lecture hall setting, Ragan, Jennings, Massey, and Doolittle (2014) confirmed previous findings indicating that upwards to two-thirds of students would multitask on their laptops while taking notes from a lecture. The author also highlights previous research which links multitasking behaviors to lower course grades. Sana, Weston, and Cepeda (2013) found that multitasking behavior associated with laptop use in university classrooms resulted in lower test scores. Similarly, those students sitting around or near laptop users also scored lower than students who were not easily distracted by others using laptops. Green, Sammons, and Swift (2017) report, however, that when specific lecture software is employed, students are more engaged in active learning in university lecture halls. Corn et al. (2014) surveyed teachers who reported problems with distractions for both special needs and mainstreamed high school students. Distractions came from the accessibility to games and music. One teacher, however, argued against what was explained to be an outdated technology policy. This teacher asks why students are prohibited from listening to music while they write their papers? After all, ". . . when I'm grading papers," the teacher asserts, "I want to listen to an MP3 player or iPod" (p. 221).

Evaluating the criticisms of some studies which suggest that laptops can obstruct classroom learning, Lindroth and Bergquist (2010) pointed to the way laptops are used by teachers as creating environments where distractions are more appealing. Without incorporating meaningful ways for students to use the technology, the pencil would also prove a distraction to learning. It stands to reason that it doesn't matter what tools we provide for students in the absence an explicit purpose tied to the curriculum.

Counter to the negative impacts discussed, Shapely, K., Sheehan, D. Maloney, C., Caranikas-Walker, F. (2009) found a significant improvement in student engagement and a parallel decrease in office referrals for middle schools. This was similar to findings reported in Massachusetts by Beebel and Kay (2010). Initial concerns were noted by parents and teachers at the onset of one program's implementation. They feared the potential for distractions which would make it difficult for students to stay on-task. These fears were alleviated, however, when positive outcomes relative to student motivation were realized (Willcocks & Redman, 2014). Pointing to a state report on Michigan's laptop program, Sauers and McLeod (2012) concluded that in spite of apprehensions due to the potential for distractions posed by individual laptops in the classroom, motivation and engagement are likely the greatest benefit of laptop programs.

Other authors also found that over time, student engagement and on-task behaviors did improve with laptop programs (Beebel & Kay, 2010; Weston & Bain, 2010). Studies by Lei (2010) and Serin (2011) indicate a significant improvement in student attitudes about learning in 1:1 programs. Keengwe, J., Schnellert, G., and Mills, C. (2011) found that the diversity of assignments including digital media products has a positive impact on student motivation, which similarly translated to an improved critical thinking and writing achievement. Dunleavy et al. (2007) suggested that the privacy allowed by electronic communication may explain why some students are more willing to ask questions of their teachers that might not be asked in front of their peers. Mouza (2008) added that as student motivation improves, gains in academics are a positive byproduct.

Attendance at school is understandably believed to be associated with a student's overall engagement with learning. Among authors looking at attendance, Aguilar-Rocca, Williams, and O'Dowd (2012) found no improvement in attendance in college lecture hall classes. This same study found that students who took notes using paper and pencil tended to score better on tests than those who used their laptop for note taking. Other studies of public school settings found mixed results when looking at attendance (Argueta et al., 2011). In some cases attendance improved while in others there was no improvement. Positive gains in attendance were found in Indiana and Michigan (Sauers & Mcleod, 2012), a focus group study of high school students in Sweden (Hatakka et al., 2013), and a study of fifth and sixth graders in one Canadian middle school (Canuel, 2010). Interestingly enough, no study has shown the implementation of 1:1 programs to have an adverse effect on attendance, whereas the positive impacts are inconsistent among studies. It is also important to note that of studies conducted concerning 1:1 laptop programs, most do not address their correlation to attendance.

Bridging the Digital and Economic Divides

Many argue that mobile learning can indeed facilitate the transformation of our contemporary educational systems, with the more lofty goals of bridging the digital divide (Hatakka et al., 2013; Keengwe et al., 2011; Mo et al., 2013; Mouza, 2008) and "disrupting the cycle of poverty" (Guimarães et al., 2013, p. 263). Both of these concepts speak to groups of haves and have-nots with regards to inequalities of access to information and financial resources, two important factors that are understandably related.

A survey of teachers of 105 high school students in a rural Midwestern high school suggests that a laptop program improved the learning experiences of all students, including those who were at-risk as a result of their socioeconomic status (Keengwe et al., 2011) . As Mouza (2008) asserted, when adequately trained teachers foster learning opportunities made available with technology, 1:1 laptop programs have the potential to afford an equality of educational experience that is not typically available for low-income students. The Mouza (2008) study looked at high poverty urban school students, finding evidence that laptops motivated and engaged them in ways that were previously unseen. Students were more apt to participate in class and were also more likely to do their homework. This was not true, however, of the comparison group of high poverty students which did not have laptops.

As we try to understand our country's inequalities and associated limitations, it is helpful to see the digital and economic divides through a macro lens, looking at disparities as an international phenomena. The One Laptop Per Child (OLPC) is a large multi-national program that was designed specifically to bridge the digital and economic divides in developing countries. A non-profit organization based in the United States, this program coordinated initial investments in excess of 250 million dollars to provide low cost laptops to students in countries such as Peru, Uruguay, Rwanda, and Ethiopia. But as Hansen et al. (2012) suggested, there is little empirical evidence support the results reported for the program. And of what evidence is available, findings appear to be inconsistent. Looking at poorer underdeveloped countries targeted by the One Laptop Per Child (OLPC) program, James (2013) and James (2014) argued that using school budgets to buy a computer for each child will greatly strain the already limited budgets of poor schools, causing a neglect of the more fundamental needs of students. Also, arguing on the simple principle of resource management, James (2010) recommended providing computers that can be shared by a number of students as opposed to giving some students their own laptop at the expense of other students having no computer access. Battro (2013) answered the critique of James (2010) asserting that the notion of a shared computer lab is outdated and ineffective. A 1:1 laptop program requires much more than simply handing out laptops. Connectivity, infrastructure, and training are critical. This is not to mention the local matching funds required by the OLPC program. As a result, the OLPC goal to reach students in the poorer countries has been unrealized in large part due to the funding limitations of those countries. Evaluating the mission and reality of the OLPC program, James (2010) pointed out that most of the laptops given out globally have gone to three Latin American countries, which are relatively wealthy compared to the many poorer countries which were intended to be served by the OLPC program.

Mo et al. (2013) studied the impact of the OLPC laptop program on 300 third grade students in three districts located in greater Beijing, China, where devices were given to students in migrant worker schools. These makeshift schools are formed by parents of students when families move to the city to find work. Because Chinese law prohibits students from attending a public school other than a school in the location of their birth, parents of these migrant children have no option for educating their children unless they band together and set up their own schools, which receive no funding from the government.

Mo et al. (2013) reported findings which suggest that the OLPC laptop program with migrant worker schools in Beijing has indeed narrowed the digital divide inherent between socioeconomic classes in China. Significant gains in computer skills were realized with the laptop schools of migrant children as compared to those migrant schools that were not part of the laptop program.

If the digital divide runs parallel to the economic divide in China, we can also see evidence of this in the United States. According to the 2013 U.S. Census, 74% percent of American households report having home Internet access. But less than half of poorer families (incomes less than $25,000) have home Internet access while more than 90%

percent of wealthy families (incomes over $100,000) have Internet access. (U.S. Census Bureau. 2014). Access and resources at school also tend to follow economic lines. Darling-Hammond (2006) pointed to international data which label the United States as having the most inequitable educational funding of all industrialized countries. Here and abroad, the digital divide can be and often is a barrier to educational equality. And in the right circumstances, individual laptops given to students can make positive efforts toward reducing inequalities of access.

Mixed Results for Educational Outcomes

As Mo et al. (2013) explained, there is a real potential for an enduring "stratification of wealth, opportunity and quality of life between peoples of the world," as a result of an unrelenting digital divide (p. 14). But as genuine as this societal concern may be, others still view the significant resource investments in 1:1 laptop programs as shortsighted and misguided (James, 2010; Purrington, 2010). Specific to meeting the goals of improving educational outcomes for all students, research over the past 20 years has shown mixed results, with arguments made both for and against investments in 1:1 programs. As studies have shown, some programs evaporate after failed implementation attempts (Goodwin, 2011; Hu, 2007; Vascellaro, 2006), yet other programs build on reported successes while a continually growing number of new programs emerge (Keengwe et al. 2011).

It is important to acknowledge that there are degrees of evidence to support both sides of a fierce debate over the viability of 1:1 laptop programs in schools (Lindroth & Bergquist, 2010). Even in some of the earliest research, a number of positive outcomes are noted. Among them, authors suggest that 1:1 laptop programs improve student engagement (Cromwell, 1999; Maine Education Policy Research Institute, 2003; Sauers & Mcleod, 2012), discipline problems decrease (Baldwin, 1999; MEPRI, 2003), more student-centered instructional practices are employed (Sauers & Mcleod, 2012), improvements in homework are noted (Baldwin, 1999), and a resulting improvement in test scores is highlighted (Gulek & Demirtas, 2005). More recent advocates similarly point to the a number of success stories where academic achievement gains are realized, particularly in the areas of Writing (Bebell, 2005; Holcomb, 2009) and Science (Zheng et al., 2014) with across the board gains for students with disabilities (Corn et al., 2012) and those who are otherwise considered at-risk, such as poorer students (Zheng et al., 2014). Other researchers speak to non-academic but related gains such as improved computer skills and self-confidence (Mo et al. 2013) and abstract reasoning and problem solving skills (Hansen et al., 2012).

On the other hand, detractors of 1:1 programs point to research to the contrary. Donovan, Green, and Hartley (2010), for example, found no improvement in academic engagement. In fact, some researchers found that laptop computers tended to distract students (Fried, 2008; Gaudreau, Miranda, & Gareau, 2014; Hatakka et al., 2013; Lindroth & Bergquist, 2010; McVay et al., 2005; Newman & Smith, 2006; Prescod & Dong, 2006; Sana et al., 2013). And with regards to academic achievement gains associated with 1:1 programs, some results show insignificant or no evidence of improvement (Bebell & O'Dwyer, 2010; Cristia, 2012; Cuban, 2006; Valiente, 2010).

Economic and Ethical Considerations

Oppenheimer (1997) is famous for being one of the first to challenge politicians and educators for throwing millions of dollars at technology in schools, charging that the investment had not been proven to correlate to improved teaching and learning. Eighteen years later, it is still difficult to refute Oppenheimer's critique (November, 2012). The problem, asserts Fleischer (2012), is that the field of study on the topic of 1:1 programs is still vastly underdeveloped. Much of the research targets attitudes of students and teachers (Spekto-Levyr & Granot-Gilat, 2012). With a wide range of varying results, others agree that there is a need for more research, specific to cause and effect, with consideration of contributing factors and their association with academic outcomes (Bebell & O'Dwyer, 2010; Sauers & McLeod, 2012; Valiente, 2010). Accompanying what Sauers and McLeod (2012) call an experimental phase within the evolution of 1:1 programs, is the great need to further understand and replicate the best practices for implementation and integration. "The reasons . . . remain, as of yet, largely unanswered. However, given the relevance to strategic investments in the public interest, further research in the area is of utmost importance" (p. 84).

Several more recent authors agree with Oppenheimer (1997), questioning the economic impact and ethical considerations of spending scarce resources on computers in poorer schools when other more basic needs go unaddressed and logistical limitations are ignored (Purington, 2010; Yujuico, 2010). James (2010) used an argument of economics to assert that a better use of limited resources in developing countries is to have as many children as possible use each computer (as opposed to the 1:1 model which is unable to reach every student). With similar conclusions, (Warschauer, 2007) found that laptops did nothing to improve the economic divide. While digital access improved, the economic plight of the poorer students held fast. Keengwe et al. (2011) acknowledged that while some academic gains were found, a predicted improvement in attendance and behavior did not materialize.

Even with the significant expense associated with purchasing individual laptops for students, mixed results on their impact on achievement (Sauers & McLeold, 2012), and the potential for adverse behaviors (Lindroth & Bergquist, 2010; Ragan et al., 2014), more and more states and school districts are adopting 1:1 initiatives. Keengwe et al. (2011) highlighted South Dakota, Wyoming, and Maine as leading the way with the percentage schools involved in 1:1 programs. Of the top three state run initiatives, Maine owns the distinction of having the first and largest U.S. 1:1 program with 34,000 computers purchased for seventh and eighth graders. And at the other end of the spectrum, California has had the fewest number of schools engaged in 1:1 programs (Devaney, 2009). Other recent state initiated programs have emerged in Indiana, Texas, Florida, Kansas, New Hampshire, New Mexico, Georgia, Louisiana, Virginia, Florida, Pennsylvania, and Vermont (Bebell & Kay, 2010). Countless additional school lead initiatives are also underway.

In today's schools, the goals of education and roles of teachers have been redefined by the integration of technology and curriculum (Spekto-Levyr & Granot-Gilat, 2012). And while U.S. schools remain largely unequal regarding funding and resources, the field of study in information and communication technologies (ICT) has been aptly condemned, arguing that there is little evidence of impact to support the cost (Cuban, Kirkpatrick, & Peck, 2001; Hansen, 2012; Valiente, 2010). Fleischer (2012) suggested that this field of study is also "easily contaminated" by marketing forces (p. 120). Even critics Weston and Bain (2010), however, along with most other detractors, speak to the potential of 1:1 laptop programs that could possibly ". . . collectively represent a heretofore unattained scale and disturbance in the equilibrium of classrooms and schools" (p. 9). The authors asserted that no other reform effort is comparable, whereas the 1:1 laptop program, for better or worse, touches every student and every teacher.

Contextual Factors

Still another category of clarifying findings is emerging that warns us that simply putting laptops in the hands of students will fail to achieve desired outcomes (Argueta et al., 2011; Bebell & Kay, 2010; Canuel, 2010; Corn et al., (2012); Cuban et al., 2001; Donovan, Hartley, & Strudler, 2007; DuFour, 2007; Dunleavy, 2007; Freimana, Beauchamp, Blain, Lirette-Pitre, & Fournier, 2010; Greaves et al., 2010; Mueller & Oppenheimer, 2014). While many authors banter about the successes and failures of laptop programs, Goodwin (2011) and others are broadening what has been primarily a binary debate, to include contextual factors such as infrastructure, implementation process, professional development, instructional practices, teacher support, and time. These related factors are beginning to shed light on what is notably a complex topic (Bebell & O'Dwyer, 2010). A study of 997 U.S. schools concluded that there are nine conditions necessary for laptop programs to effect improved achievement in schools (Greaves, Hayes, Wilson, Gielniak, & Peterson, 2010, p. 23):

1. A systematic integration of technology all intervention classes
2. Time for professional development and collaboration monthly (minimum)
3. Collaborative and cooperative learning among students
4. Weekly (minimal) Integration of technology in core subject courses

5. Weekly (minimal) use of online formative assessments

6. Lower computer ratios to produce greater impact

7. Virtual field trips at least monthly

8. Student use of search engines daily

9. Principals trained in teacher buy-in, best practices, and technology transformed learning

And if properly implemented, add Greaves et al. (2010), technology will not only improve academic outcomes, but will also save money.

Planning and Implementation

Gleaning evidence and insight from both sides of the debate and considering the complexities associated with education reform, teaching and learning, and technology integration, it becomes apparent that our discussion is not about whether or not 1:1 laptop programs do or do not have a viable role in twenty-first century schools. Rather, the questions we must continually ask and answer as the role of technology evolves is two-fold (Marcinek, 2015): First, what are our educational aims - what do we hope schools will accomplish for our children? And secondly, under what conditions can we realize these hopes? November (2013) answered these questions at their crux, proposing that instead of calling it a one to one initiative, which speaks to machines and wires, the purpose would better be served if it were called a “one to the world” initiative (p. 1). This, the author suggested, would give clarity to purpose with direct attention to the ultimate goal. And as Marcinek (2015) asserted, "Challenging students to think, be creative, and explore different pathways of inquiry is just as essential as turning a device on" (p. 2). It is the difference between having technology and leveraging technology.

Canuel (2010) contended that to use a laptop program to make systemic change in education, schools have to design an integration plan that includes monitoring how teachers and students use the technology. This begins with how a program is implemented.

Just as there is a wide range of findings for impacts of 1:1 laptop programs, there is an equally wide range of approaches to program implementation (Dunleavy et al., 2007; Twining, Clark, & Chambers, 2014). Implementation models for 1:1 laptop programs can look quite different from school to school. In Maine, for example, a statewide laptop distribution was adopted but the approach varied greatly among more than 240 middle schools (Silvernail & Lane, 2004). Some schools handed devices out immediately while others waited for several months. Some only integrated laptops in a couple designated classes as opposed to using them across all courses. Some allowed students to take their laptops home and others kept them for school use only. Training and support for teachers also looked very different among the schools in Maine. Given the eclectic variations of implementation models, Silvernail and Lane (2004) contended that there should be no surprise that the results reported were mixed in correlation with the Maine Educational Assessments (MEA). Similar to programs in Maine, implementation models and overall results of 1:1 laptop programs across the country and around the world are likewise mixed. Silvernail and Gritter (2007) asserted that the comprehensive model for 1:1 initiatives is the most effective approach, whereby each student has a laptop that can be used in all classes and can also be taken home. And arguably, programs that are carefully implemented can and do yield positive educational outcomes (Hatakka et al., 2013).

Still, there are genuine barriers that cannot be neglected when conceiving the launch of a 1:1 program (Jackson, 2017; Jouneau-Sion & Sanchez, 2013; Keengwe et al., 2011). First and foremost, the cost of implementing a successful 1:1 laptop program includes much more than the price of a laptop. Staff training and support, Wi-Fi infrastructure, software, and a plan for repair and replacement need to be very real parts of the program budget. Once these costs are added, writes Valiente (2010), the actual price of the program is estimated to be over a thousand dollars annually per student. In an environment when most schools are seeing reductions in funding, taking on a laptop program will have to include decisions about what monies can be moved from other areas in order to build an ongoing budget for the 1:1 laptop program. For example, funds that might be budgeted annually to maintain computer labs and replace classroom computers could be redirected toward the laptop program. Similarly, monies spent for hardbound textbooks can be used to purchase electronic interactive textbooks. Many projects for student laptops spring up with funding from grants or other one-time funding sources. To plan for a successful program, Guimarães et al. (2013) argued for a built-in sustainability plan. Otherwise, a 1:1 program will be one and done.

Another potential barrier is the lack of an integration plan. Marcinek (2015) suggested that technology in education has become so important that it can no longer be conceived as a separate class in a lab. Technology today is "a literacy that must be threaded throughout the fabric of a school" (p. 3). And as Cuban et al. (2001) found, access to computers alone rarely changes teaching practices. When the computers were used, they were used in ways that only reinforced traditional teacher-centered models.

With this in mind, a strategic plan for integration must include a clear and shared vision of how the laptops will be used.

It is unfortunately common in education that we forget about the problem of time, one of the most formidable obstacles to educational reform. For example, teachers will often need to use their planning time to learn a new technology, which makes it difficult to plan the actual lesson. Shapely et al. (2009) told how the Texas Immersion Pilot (TIP) failed by most accounts because key elements in the implementation process were left out. Time for training teaches was among the missing components. The TIP program assumed that simply immersing schools in technology would achieve the goals of improved student achievement. The authors who evaluated the TIP charge that by neglecting consideration for hardware, software, digital content, and professional development, these Texas schools were set up for failure at a cost of 20 million dollars in federal Title II monies.

Other potential barriers include a lack of support from administration, staff with negative attitudes or insecurities about using computers, physical space for laptops, supervision, a lack of technical support, difficulties with curriculum integration, and poor wireless access. Numerous obstacles faced by the OLPC project were related to technical problems with inadequate infrastructure and support (Guimarães et al., 2013). Many students in these poorer countries did not have a place to charge their laptops, let alone access the internet. And while virtually all public schools in the United States have internet access, less than half of those schools have adequate wireless access (Cohen & Livingston, 2013).

Newhouse, Land, Cooper, and Twinning (2014) argued that the two elements most essential for success of 1:1 programs are good school leadership and an organized integration of the curriculum. Considering this, the authors affirm that the role of the school technology coordinator is critical. The success of a 1:1 laptop program is also closely associated with the perceptions of strong administrative leadership and support. Corn et al. (2012) agreed that when administrative attitudes about technology initiatives are enthusiastic, teachers are more likely to be open and receptive to the change.

When looking at 1:1 programs in Massachusetts involving seven middle schools, Beebel and Kay (2010) found that the teacher bears the greatest burden for implementation. As a result, the success of technology integration is most heavily dependent on the teacher and allowing for time, training, and support. More specifically, according to Inan and Lowther (2010), no other factor impacts the success of a laptop program more than the beliefs and attitudes of teachers. Şad and Göktaş (2014) recognized that course objectives and mobile learning tools will not work together unless they are aligned. The very real challenge, however, is that teachers, the role models for students, are not prepared and may resist the change. Schools need to develop reasonable timelines for implementing 1:1 programs. Keengwe et al. (2011) recommended investing more for professional development than what is spent on the equipment. Without time and resources dedicated to training staff for successful integration, we cannot expect to have a successful implementation. In some of the programs that have failed, schools have spent less on teacher training than what they have spent on repairing laptops that were misused. Agreeing with Newhouse et al. (2014), however, other stakeholders in addition to teachers must be considered as well. This includes support staff, administrators, students, parents, and the community. As Fullan (2005) wrote, any sustainable systemic change is dependent upon a social and cultural supports.

Fajebe, Best, and Smyth (2013) reminded us that changing a pedagogical model that has been in place for hundreds of years is a very complex process that does take time. Add technology to the change you are looking to make and the process becomes even more challenging. Jouneau-Sion and Sanchez (2013) warned that for transforming educational systems to remain relevant in the 21st century, changes in systems and policies must engage a participatory process that includes educators, students, and their parents. One factor that has appeared to be helpful is the use of a parent orientation night for laptop distribution (Holcomb, 2009).

Zucker and Light (2009) call for a holistic approach to transforming schools with technology. This balanced approach recognizes that a successful change of this magnitude will involve many component changes and all must be identified and given attention. Accordingly, carefully developed policies shaping all areas will be necessary for a program to be successful. More directly, the authors charge, without addressing the more broad and genuine need for education reform, a laptop program is a futile effort for any school or nation. November (2013) challenged schools to focus on the educational goals specific to content areas. For example, how can we use computers to apply mathematical skills to real-world problems? Without tying programs to clear curricular goals, handing out laptops is little more than spraying and praying.

Laptop projects will be far from perfect at the start and like any major initiative, time will be needed for adapting and adjusting the program. As Sauers and Mcleod (2012) found, the impact measures after the second year were significantly improved in comparison to results at the conclusion of the first year. Looking generally at the change process in schools, Fullan (2001) cited consistent evidence to support what is referred to as an "implementation dip;" a short-term negative impact resulting from the new skills required (p. 40). As a result, the early stages of a new program can be difficult and confusing until the needed skills develop and performance improves. Without commitment and strong leadership, many programs will fail because they give up at the first sign of an initial decline. In fact, wrote DuFour (2007), there is a predictable pattern of reform efforts in the United States, in which bold programs are enthusiastically initiated, only to be terminated and replaced by something more easily accepted but more often providing only a band aid solution. To combat this pattern of giving up when the going gets tough, Schlecty (2005) suggested a one word solution - "persistence" (p. 23). Holcomb (2009) echoed Fullan (2001) and DuFour (2007), insisting that the actual impact of a 1:1 initiative cannot be known until the program has had time to mature. Researchers who study the change process in schools suggest that with any significant innovation it takes five to eight years to truly understand the full impact.

Still, degrees of success and failure vary among programs in part as a result of the implementation process employed. Weston and Baine (2010) agreed that when laptop programs fail, it is for the same reasons that other large scale education reform initiatives fail. It is not because they are bad ideas, but rather a systemic flaw in the way we approach change in schools. But rather than look at the bigger problem, it is easier to blame and abandon the innovative solution. According to these authors, there are a couple of entrenched reasons for failed education reform efforts. First, and in accord with November (2013) and Marcinek (2015), when a new program is employed, schools become so preoccupied by the new program that they lose sight of their end goal; what they ultimately hope to accomplish with students. Weston and Baine (2010) gave examples to show how other professions use a more outcome-based approach to using new technologies:

> when a surgeon uses an arthroscope to trim a cartilage, a structural engineer uses computer-assisted design software to simulate the stresses on a bridge, or a sales manager uses customer-relations-management software to predict future inventory needs, they do not think about technology. Each one thinks about her or his professional transaction" placing the end goal at the forefront. (p. 10)

Ultimately, these other professions focus on what needs to be accomplished, using the technology to do it better and more efficiently. Echoing Inan and Lowther (2010), technology, or any innovative effort for that matter, is simply a means to an end.

Secondly and perhaps even more important, Weston and Bain (2010) pointed out that most changes in education have been done "to it not by it" (p. 9). Very little changes in the classroom when we neglect what teachers do and care about. The authors maintained that the answer to the bigger question of school reform in general, is to foster self-organizing school environments where solutions emerge from the rubble of the problems they are intended to solve. As opposed to the typical top-down model, teachers and building leaders need to be at the center of change efforts, especially since they are the ones responsible for seeing them through. Laptops programs are like other education initiatives. Without a sound implementation plan with attention given to the change process, they too will live a short life, even though this technology may very well hold the keys to the greatest opportunities to improve education.

Instructional Practices

Whether positive or negative results are ascertained, “the ubiquitous deployment of laptops breaks through the traditional barriers to learning and teaching” (Canuel, 2010, p. 39). Approaches vary greatly. Research results are mixed with diverse implementation approaches and contextual factors. What does appear to stand out is that technology generally augments the instructional practices that are already in place (Twinning et al., 2014). Bebell and Kay (2010) concurred in their report on the largest worldwide deployment of laptops (over two million and counting), the OLPC program (One Laptop Per Child). Evaluating the OLPC, the authors assert that laptops alone do not increase achievement. Or as Goodwin (2011) explained “Rather than being a cure-all or silver bullet, one-to-one laptop programs may simply amplify what's already occurring—for better or worse—in classrooms, schools, and districts” (p. 78) .

How laptops are used speaks directly to the question of instructional practices. Cuban (2006) said that in effect, the purported "technology revolution has no clothes" (p. 1). Arguing that very little evidence supports the claims associated with 1:1 programs, the author points to the Maine Learning and Technology Initiative (MLTI) and the Texas Technology Immersion Pilot (TIP) as examples. Several other studies also show very limited effects of 1:1 initiatives, but prudence requires us to take a closer look at the operation of these programs. When we ask why some programs do not yield the desired results, Canuel (2010) countered by suggesting that the problem has nothing to do with the laptop. Instead, failed attempts are a result of how programs are integrated. Any initiative that is poorly implemented will have a similarly limited impact. Beebel and O'Dwyer (2010) reminded us that the definition of a 1:1 laptop program talks about ratios and access. It does not say anything about learning goals, teaching paradigms, or educational practices in general.

Most researchers assert that having technology does not equate with using technology. Valiente (2010) employed the "productivity paradox" in explaining this reality (p. 7). In essence, the instructional practices needed to realize technology integration are the very practices afforded by the technological innovation. It may seem obvious and oversimplified, but without real changes in how we use computers for learning, we will not have changes in learning outcomes.

With or without laptops, improved learning cannot be detached from improved instruction. Where traditional rote learning approaches are reinforced with laptops, traditional results will follow. As Cristia et al. (2012) reported, this reality was observed among 319 primary schools in Peru's OLPC program. Both positive and negative outcomes can be connected to 1:1 laptop programs. And as Gaudreau et al. (2014) among others insisted, one of the most significant factors impacting outcomes is way in which the laptops are used. With this in mind, a number of authors have gone beyond a search for correlations between laptops and achievement in an effort to better understand the role of instructional practices.

The most basic measure of how laptops are used looks at how often they are used. Without exception, researches who look at the frequency of use find that increased achievement is associated with how often laptops are used. Specifically, daily use of laptops results in improved achievement across studies (Addis & Falk, 2010). The impact of laptops on state MCAS scores for students in five Massachusetts middle schools also showed a strong correlation to how often the laptops were used in the classroom. As Beebel and Kay (2010) explained, laptops were used most often in Language Arts and Social Studies classes and least often in Math classes. A significant correlational increase in scores was found for Social Studies and Language Arts while this was not the case for Math scores. Studies of 1:1 laptop programs in Michigan, Maine, and Florida show similar results across Math, Writing, Science, and Social Studies, where positive academic gains were associated with the more frequent use of laptops (Argueta et al., 2011). Warschauer (2007) identified the insufficient use of laptops as contributing to poor results and even magnifying inequalities that already exist. Without being intentional about how and when laptops are to be used for learning purposes, students who are already academically oriented will benefit from a laptop program while those lesser achieving students will not. As a result, the achievement gap can actually widen in spite of the hope that laptops will level the playing field.

Without the coordinated integration of technology, explain Spekto-Levyr and Granot-Gilat (2012), it is very difficult if not impossible for teachers to target the needs of every student in the classroom. While three schools in Victoria, Australia were already transforming instructional practices to connect student learning to the real world, the new laptop program was not seen as a catalyst for reform, but rather an amplification of what was already taking place. Providing student laptops did not cause, but made it easier to employ better teaching strategies. For example, classrooms were laid out in ways that supported both individual and group work. And while efforts were being made to make learning more student-centered, the success of these efforts varied depending on the clarity of directions given by teachers. For better or worse, this was not because of the addition of laptops. Good and bad instructional practices, however, became more apparent when laptops were added (Twinning et al., 2014). Dunleavy and Heinecke (2007) agreed that it requires the right conditions, but laptops can have a positive impact on student achievement, allowing teachers to cultivate a more individualized learner-centered environment.

Twenty-first century learning requires teachers to move beyond their traditional pedagogy. This entails much more than simply being the expert in ones content area. "Chalk and talk" no longer work (Jouneau-Sion & Sanchez, 2013, p. 267). Learning is now more about knowing what to do with information (analyze, critique, synthesize, and collaborate in our understanding). Lowther, Ross, and Morrison (2003) suggested that teaching practices have been historically resistant to change, and as a result, most classrooms still reflect a teacher-centered approach. When computers are added to classrooms, they tend to be used more for drill and practice than for inquiry and problem-solving. Freimana et al. (2010), however, described a shifting paradigm in education where the value of the learning product is beginning to yield to an emphasis on the learning process. Still, nothing impacts behavior and academics in the classroom like the pedagogical beliefs of the teacher (Addis & Falk, 2010).

The availability of cognitive tools in schools should facilitate the transformation, acceleration, differentiation, deepening, and maximizing of learner outcomes (Weston & Baine, 2010). Realizing these expectations, however, requires the implementation of teaching practices that are supported by research. These practices, suggest the authors, include "cooperative learning," "differentiated instruction," and "problem- or project-based learning" (p. 11), and have been proven to produce significant improvements in achievement. A truly differentiated approach for all students is only possible when teachers have just-in-time or immediate data about the needs of each student. Standardized assessments and even unit tests or quizzes are simply too late. Collaborative learning allows students to work together to achieve a deeper understanding than what can be garnered through individual efforts. And problem-solving or project-based learning creates real-world relevance while connecting new skills and concepts to what students already know and in ways that sustain what is newly learned. Technology helps to facilitate these strategies. And as Weston and Baine (2010) maintained, the fully integrated use of laptop computers involves a shift in paradigm whereby the notion of technology tools is replaced with the concept of cognitive tools.

When used strategically in the classroom, added Serin (2011) and Corn et al. (2012), computers make it possible for students to become active learners, construct understanding, develop problem-solving skills, and to find other possible solutions. And as Mouza (2008) suggested, laptops can and do change the dynamics of teaching and learning in ways that foster improved pedagogical practices. Instructional practices built around inquiry-based strategies, interdisciplinary connections, cooperative learning, teacher facilitators, and constructivist methodologies emerge naturally in a ubiquitous laptop environment. Over time, teachers in 1:1 laptop programs do employ more project-based learning activities and also become better collaborators with their coworkers (Sauers & McLeod, 2012).

Holcomb (2009) affirmed that how laptops are used in the classroom is critical to a program's success. Comprehensive integration requires that teachers reform instructional practices without losing focus on their curriculum and standards. In Michigan's Freedom to Learn (FTL) laptop program, laptops were integrated in ways that were aligned with course curriculum and helped to facilitate constructivist strategies including learning through inquiry and collaboration. But as Rebora (2016) reports from a survey of 700 high school teachers, while attitudes toward using new technologies were good in practice, most were only using online resources for reading assignments and practice or drill. The more critical twenty-first century skills afforded by modern technologies still appear to be more elusive.

In *Good to Great*, Collins (2001) concluded similarly that the role of technology in the world of business is that of a mere tool, assuring readers that "technology alone never holds the key to success. When used right however, technology is an essential driver in accelerating forward momentum" (p. 159).

Professional Development

Quality professional development is statistically significant and essential for 1:1 laptop programs to succeed (Beebel & O'Dwyer, 2007; Holcomb, 2009; Inan & Lowther, 2010; Klieger, Beh-Hur, & Bar-Yossef, 2010; Mouza, 2008; Twinning et al., 2014). Unfortunately and more often than not, schools miss the target when it comes to implementing systemic change because they lose sight of what it is they actually want teaches to do. As a result, new programs tend to fail because adequate preparation is considered only as an afterthought.

> In every case of failure I have observed, the one-to-one computing plan puts enormous focus on the device itself, the enhancement of the network, and training teachers to use the technology. Then, teachers are instructed to go! But go where? That's the critical question that must be addressed first. (November, 2013, p. 1)

What then is it that we want teachers to do and how can this direction be clarified through professional development?

Studies reveal several factors that help to make professional development successful. First, it must be embedded in the specific subject the teacher teaches. Effective change, reminded Valiente (2010), begins with a clear understanding of learning goals. What do we ultimately want to accomplish (Marcinek, 2015)? To this end, we cannot paint wide brush strokes with professional development. While our change process must be holistic (integrating technology training with pedagogical reform), professional development must be specific and within the content area (Klieger et al., 2010). In the ideal situation, added Valiente (2010), an ICT specialist is able to work with Math teachers and focus on how the technology will be applied in the Math class, for example, in a way that brings about student-centered practices. In fact, wrote Harris and Sass (2008), research tells us that there are only two types of teacher training that effectively impact learning goals: 1) professional development within the subject area and 2) that which is acquired by way of on the job experience.

In addition to improving pedagogical practices, with the significant investment involved with laptop programs, we must insure that they are being used in the most effective ways (Dunleavy et al., 2007; November, 2013). This requires opportunities for teachers to learn how best to manage their classrooms, integrate curriculum resources, and use the technology with best practices for instruction and assessment. Again, addressing how laptops will be integrated within the content area produces the best results. Unfortunately, effective integration strategies are often altogether absent when 1:1 programs are deployed (November, 2013).

Secondly, professional development should be collaborative and challenge teachers to be aware of their own thought processes as a way to understand those of others (metacognition). The historic nature of classroom education is that too often, teachers operate on an island without the benefits of shared knowledge and experiences of colleagues. Yet, research has clearly shown for decades that students benefit when teachers collaborate (DuFour, 2007). Allan, Erickson, Brookhouse, and Johnson (2010) cited evidence in suggesting that by collaborating in the development of curriculum, teachers also improve their pedagogical strategies, moving more toward facilitators of learning in student-centered classrooms.

Third, professional development is not a single event and requires time. It is ongoing, regular, reinforced, and is part of a school's overall continuous improvement process (Holcomb, 2009; Silvernail & Gritter, 2007). One of the most commonly overlooked barriers to professional development is the allowance for time (Cuban et al., 2001). We hand out manuals and point teachers toward webinars and video recorded trainings, or at best bring staff together for a one-time training session. But, we neglect the real need for the time required to accomplish these tasks. With laptop programs, there is additionally a very real need to allow time for navigating and understanding software programs. Without planning for the scheduled time needed for teachers to learn and apply concepts, the efforts made by individuals will be just that - individual. And without teachers having the ability to collaborate in the training process, we do nothing to model and reinforce a movement toward student-centered practices in the classroom. Professional development is not only about learning new skills. Effective leaders, wrote November (2013) must also help teachers, families and communities "to let go of existing structures" (p. 4). Learning new methods, explained the author, is actually easier than unlearning old practices. This requires a plan for professional development that includes adequate time to prepare teachers for change.

Logistically, providing teachers with laptops over the summer to prepare for the upcoming year has proven to have a positive impact on the implementation process (Holcomb, 2009). More specifically, Canuel (2010) contended that teacher training should take place three full months prior to handing laptops to students. Administrators have to be on board and supportive of professional development efforts. As Canuel (2010) and Corn et al. (2012) suggested, one of the best ways to show this support is for administrators to actively participate with teachers in the training and even in some cases deliver the training.

When looking at what motivates teachers to participate in the change, Salajan, Schönwetter, and Cleghorn (2010) reminded 21st century reformers that one thing has not changed. That one thing is the need for a sense of self-efficacy. Teachers need to know that what they are being asked to do matters and will make a difference.

Planning for professional development also requires that we consider why resistance to change occurs. Among these reasons, suggested Silvernail and Gritter (2007), are a lack of compensation for time, mixed messages sent by leaders, fear of the unknown, interests of power groups, and a history of previous attempts failing. For these reasons, whether recruiting teachers for a pilot group or hiring a new teacher to your staff, leaders have to be intentional about finding people who are open to and willing to change.

Technological change is inevitable. Arguing otherwise would be like taking a stand against using a shovel, determined to continue digging with a stick. But as Cuban et al. (2001) wrote, the technology changes in education will be more of a slow revolution, similar to the gradual expansion of electricity following its birth.

Demographic Implications

Age/Grade Levels of Students

Aside from academic outcomes as they apply to all students in relation to laptop programs, a number of studies have looked at the link between such programs among subgroup populations. Understanding a relationship between technology and student success in general is a very complex undertaking (Bebell & O'Dwyer, 2010; Fajebe et al., 2013; Jones & Cowie, 2010). Because of the significant correlation between the pedagogical practices of the classroom teacher and the impact of laptop programs, it is often difficult to conclude the strength to which other related factors may influence positive or negative results. As researchers agree, the teacher still plays the most vital role in determining the success of integrating student laptops (Canuel, 2010; Corn et al., 2012; Holcomb, 2009; Inan & Lowther, 2010; Mouza, 2008; Twinning et al., 2014).

Many initiatives are implemented at specific grade levels, (i.e., laptops given to all fifth graders in a school, district, or state), with the research on those programs limited accordingly. Maine's state initiative is the largest program in the United States with 34,000 laptops given to seventh and eighth graders (Keengwe et al., 2011). Some researchers, however, have attempted to compare a wider spectrum of students across ages and grade levels. While the Texas middle school laptop program, for example, was seen as having failed to accomplish its goals on the whole, data from examining this TIP (Texas Immersion Pilot) suggests that a more positive impact on academics was observed with their seventh and eighth graders than with students in grades five and six (Shapely et al., 2009). This is similar to a study conducted in Ethiopia which showed gains in upper grade levels while lower grades saw no improvements (Hansen et al., 2012). Canuel (2010), however, tells of very positive results for fifth and sixth graders at one rural school in the province of Quebec, Canada. And looking at grades three through five in one poor urban school in Delaware, Mouza (2008) found that all grade levels in the laptop group outperformed their peers who did not have laptops. This concurs with findings across elementary grades in Michigan's statewide laptop program (Holcomb, 2009). But when comparing research specific to programs in Florida, Maine, North Carolina, Michigan, Pennsylvania, Texas, and Virginia, positive impacts of 1:1 programs were still most common at higher grade levels than at lower grade levels (Arguenta et al., 2011).

In addition to the confounding factors of implementation models and teacher practices, the reality is that laptops are much less likely to be handed to elementary students to take home. The rareness of such programs at lower grade levels makes it even more difficult to understand why or how a student's age/grade level might be related to the success or failure of 1:1 laptop programs. This is especially true considering that other factors, such as teacher attitudes about technology, appear to have a greater influence on implementation outcomes (Fleischer, 2012).

Gender

Looking at gender, Hatakka, M., Andersson, A., and Grönlund, Å. (2013) reported significantly fewer females are studying or working in technology-related fields than are males. This imbalance also appears to play out when looking at student attitudes about technology in the classroom. Incantalupo, Treagust, and Koul (2014) looked at 700 high school biology students and determined that by in large, males used and preferred technology significantly more than females. But in spite of similar results where boys have more positive attitudes about technology in primary grades, McKenney and Voogt (2010) found no difference in computer skills when considering gender. When looking specifically at 1:1 laptop programs in schools, a study of Brazil's One Laptop Per Child (OLPC) program surveyed students and found that while girls tend to use their laptops more for schoolwork, boys enjoy their laptop more for playing games. Serin (2011) found similarly that high school boys tend to use their laptops for play nearly three times more than girls. Dunleavy et al. (2007) looked specifically at high school Science classrooms where each student had a laptop. This study found that boys in an urban American school showed significantly better Science achievement than the girls who were in the same laptop program. Considering computer skills however, Hohlfeld, Ritzhaupt, and Barron(2013) found results that countered many other similar studies, suggesting that female students attitudes and competencies relative to technology were better than their male peers. After applying statistical measures to account for other factors, however, the authors report a loss of any significance in the difference between boys and girls as a predictor. These revised conclusions concur with those of McKenney and Voogt (2010). More importantly, Hohlfeld et al. (2013) challenged many other studies which they suggest make assertions about gender and technology while abandoning the use of advanced statistical analysis. The unfortunate reality remains that as with other areas of research on the topic of 1:1 laptop programs, results are mixed and far from conclusive with regards to gender analysis.

Economically Disadvantaged Students

A number of researchers have given special attention to the impact 1:1 laptop programs may or may not have on economically disadvantaged students, with the hope of identifying an improvement in the academic disparities between socioeconomic divisions. As previously discussed, the digital divide is one of access, mirroring and interconnected with the economic divide. Low-income students and especially low-income minority students have a more limited access to technology both at school and at home. Issuing school laptops, wrote Mouza (2008), can help overcome this disparity by creating "supportive school environments that can foster student responsibility, competence, and autonomy in relationship to technology and learning, thereby leading to increased motivation and greater academic aspirations" (p. 449).

Warschauer (2007) compared 10 schools with elementary, middle, and high school students. Schools were in California and Maine and included urban, suburban, and rural settings. While this study suggests that laptops played a pivotal role in improving students' academic achievement overall, there was no evidence to indicate a narrowing of the achievement gap between wealthy and poor students.

And because attitudes about how technology is used are heavily influenced by family members at home, Holloway and Green (2003) warned that providing laptops to each child may actually produce what is known as the "Sesame Street effect" (p. 1). This phenomenon occurs when something is designed with the intent of helping improve the plight of poor children, but it is the more wealthy families who take advantage of the opportunity, ultimately widening even further the gap between the rich and poor. An example of this can be seen in the Head Start programs which were initiated to help poor children catch up with their peers before entering kindergarten. While many poor families have not sent their children to Head Start, a trend has emerged where families with means see the benefits and do send their children to preschool programs. As a result, poorer children are now even further behind their peers when entering elementary school.

Rather than 1:1 laptop programs impacting the success of disadvantaged students, Warschauer (2007) found that the success of the 1:1 program was dependent on the socioeconomic status (SES) of students and where their school was located. As this author explained, students who grew up in homes where it was assumed they would be going to college were more likely to use the provided technology to strengthen their academic standing in school, while those without these expectations tend to value the technology for other purposes.

Summarizing the research pertaining to income status and its relationship with 1:1 laptop programs, researchers have not been able to find evidence that laptop programs narrow the achievement divide between wealthy and poor students. Most, but not all, report improved achievement for all students, regardless of socioeconomic status. Others suggest a potential for an even greater digital divide with 1:1 programs. As Mouza (2008) advocated, there is an unquestionable need to study the impact technology immersion can have on the disparities among schools and their students.

Special Needs Students

Some of the most promising findings regarding the benefits of 1:1 laptop programs come from the analysis of their impact on the achievement of students with special needs or disabilities. Assistive technologies are not new to special education.

Audio books and hearing aids, for example, have been used for decades to meet the need of these students. For this reason, wrote Robinson (2014), students with special needs transition easily to the tools provided with laptops.

As with studies across all student populations, students with special needs tend to benefit academically in the area of writing (Canuel, 2010). Corn et al. (2010) showed similar results for writing, explaining that laptops allowed students who typically struggle with learning to produce written work similar to the quality of their peers. The ability for laptops to facilitate individualized learning also resulted in improved math scores. And, for visually impaired students, laptops provided accommodations making it easier to read, and as a result improved their reading skills.

Technology has been embraced with very positive results for students on the autism spectrum (Robinson, 2014). Computers, the author explains, simplifies interactions, which are likely the greatest barriers these children face in their daily lives. With students who cannot speak, for example, technology facilitates communication in ways that even parents could never have imagined.

According to Harris and Smith (2014), teachers and parents in the Maine Learning Technology Initiative (MLTI) affirm that overall, students with disabilities benefit greatly from laptop technology. The devices engage students who tend to be disengaged, improve organizational skills, and boost the quality and quantity of their work. This was particularly true of students who struggle with writing as a result of fine motor skill deficiencies. With only a few exceptions, the vast majority of special needs students in the MLTI benefited from the use of laptops. In the cases of outliers, it is believed that these special needs students were more distracted by the technology than aided in their learning. Also, it was noted that special education students are more easily frustrated and less patient when minor problems with technology occur.

Impact on Academic Achievement

1:1 laptop programs pose a significant problem for researchers to consider and the call for further research is essential (Hansen et al., 2012; Lindroth & Bergquist, 2010). Fleischer (2012) argued that this field of study has made little progress after more than a decade of research. While both the potential and expense are great, overall results are mixed and implications are weak. November (2013) furthered the critique of research efforts on the topic, pointing out that as educational resources diminish, research must take us in a direction that realizes an improvement in academic achievement. Otherwise, we are better off staying with the original 1:1 initiative - one number 2 pencil per child. The intent of this paper is to further explore the impact a 1:1 laptop program can have on student achievement at one rural high school in Ohio and with what conditions any measurable impact can be associated. First, we look to the findings already reported in this central area of academic achievement.

Overall Grade Point Average and Standardized Test Scores

Beginning with the broader effects of 1:1 laptop programs on academic achievement, a number of studies have documented the impact on grades and overall grade point average (GPA). In a Canadian university study of 44 undergraduate students in a large lecture hall class where laptops were permitted but not directly incorporated into the class activities, it was found that the laptop caused a distraction for students using them (multitasking during the lecture) as well as those students who were near the students with laptops (Sana et al., 2013). Both laptop users and their neighbors had lower class grades than did those in the class who were not using laptops or were not close to laptop users. Where laptops were an intentional part of the instructional and learning process in secondary schools, however, Lei and Zhao (2008) determined that there was a marginally significant increase in the grade point average of students after being given laptops, compared to the previous year without laptops. Gulek and Demirtas (2005) saw a significant improvement in grades among 259 middle school students in year one. These findings were confirmed longitudinally over a three-year period. Holcomb (2009) and Corn et al. (2012) likewise reported overall higher achievement as measured by grades and grade point average. Taken together, these and other authors appear to confirm that simply having a laptop in the classroom does not improve learning (Beebel & Kay, 2010;Canuel, 2010; Cuban et al., 2001; Dunleavy et al., 2007; Holcomb, 2009; Jouneau-Sion & Sanchez, 2013; Keengwe et al., 2011; Newhouse et al., 2014; November, 2013; Şad & Göktaş, 2014; Silvernail & Gritter, 2007; Twinning et al., 2014; Valiente, 2010; Weston & Baine, 2010; Zucker & Light, 2009). And, without a clear vision, specific goals, and strategies for effective integration, laptops can actually have an adverse impact on academic achievement. Still, across the research available, most authors report at least some degree of positive effect on grades and overall GPA.

Buzzetto-More and Alade (2006) explained that the standards and outcomes underpinning the accountability and assessment movement are intended to evaluate student achievement and hold schools accountable. The proliferation of state standardized testing over nearly 30 years is a direct result of this mission. These tests are used to prescribe interventions, determine if students are eligible to advance in grade levels and ultimately receive a high school diploma, align curriculum, evaluate teachers and schools, and inform policy decisions. With the large investment in laptop programs, it is understandable that research has attempted to link the effects of 1:1 initiatives to achievement as measured by standardized tests. But as Mouza (2008) wrote, it can be difficult to couple 1:1 laptop programs with standardized tests scores, especially in the first year. The Texas Center for Educational Research, for example, compared 21 middle school laptop programs with 21 schools without 1:1 programs. Researchers found no evidence that the Texas Technology Immersion Pilot (TIP) had any impact, negative or positive, on state test scores (Cuban, 2006. *The Laptop Revolution Has No Clothes*). Similarly, Hu (2007) concluded that after seven years, a Liverpool, New York program did not produce any gains in their state test scores.

In Michigan, however, access to laptops and the degree of their use proved to be strong predictors of improved scores (Sauers & Mcleod, 2012). Gulek and Demirtas (2005) reported higher state test scores both in the short term and over several years in California's Harvest Park Middle School. And even though the Massachusetts initiative was found to have had a plethora of methods for 1:1 laptop implementation, the impact on their Massachusetts Comprehensive Assessment System (MCAS) was also found to produce increased test scores (Beebel & Kay, 2010). Similarly, Holcomb (2009) argued that 1:1 programs have had a significantly positive impact on standardized tests when looking at programs on the whole across the country. As with grades and GPA, laptops do not necessarily improve state test scores directly, but make it possible for learning opportunities that are deeper, more open-ended, constructive, collaborative, and reflective (Freimana et al., 2010). These are processes that have been associated with improved student learning and achievement, which ultimately translate to better standardized test scores. Buzzetto-More and Alade (2006) asserted that e-Learning and technology do hold the potential to accomplish our educational assessment goals. But Canuel (2010) argued that assessing the impact of laptops should include more than the measure of traditional academic skills. Namely, they should also evaluate 21st century skills. Unfortunately, most standardized state tests are not designed for measuring the core 21st century learning goals that are more directly aligned to laptop programs: critical thinking, application, collaboration, technical agility, initiative, oral and written communication, analyzing information, and imagination (Silvernail & Lane, 2004). Even with their limited focus, however, standardized state assessment results do appear to be impacted positively by 1:1 laptop programs in most situations.

Social Studies Achievement

Measures of academic achievement can be categorized by what is commonly referred to as the core subject areas: Social Studies, Science, Mathematics, and Language Arts. Research in the area of History or Social Studies achievement is nearly absent from all discussions on the topic of 1:1 laptop programs. In the very few cases where one can infer the consideration this discipline, it is only part of an inclusive statement indicating, for example, that students with laptops outperformed their peers across all core subject areas (Arguenta et al., 2011; Sauers & Mcleod, 2012), or that no academic gains were observed across disciplines (Hu, 2007). Considering this vacuum in the 1:1 laptop body of research, there is an unquestionable need for time and attention dedicated to exploring Social Studies achievement and its relationship to 1:1 laptop programs.

Science Achievement

A research analysis by Addis and Falk (2010) found limited and mixed results when looking at the impact of 1:1 laptop programs on Science achievement. Similar to other subject areas, findings tend to be coupled with varying implementation models (Argueta et al., 2011; Beebel & O'Dwyer, 2010). Crook, Sharma, and Wilson (2014) looked at high school Science achievement in Australia, the country credited for having the first national 1:1 laptop initiative. These researchers looked at the standardized test scores of twelve laptop high schools specific to Biology, Chemistry, and Physics courses, comparing students educated with laptops to those without. Findings report that laptop students performed better and at a statistically significant rate on an external standardized examination. Of the three Science courses, the greatest gains were in Physics. Accompanying qualitative data suggest that Physics classes made more use of computer simulations and spreadsheets. This echoes the relationship between the impact of laptops and the integration and frequency of use asserted by Argueta et al. (2011). Dunleavy and Heinecke (2007) found that while improvements were not seen in Math scores, they were observed in Science scores among the same sample population. These authors suggested that the computer-based visual and interactive simulations used to teach Science help to explain the positive effects.

Comparing at-risk students (i.e., English language learners, minorities and poorer students) to students who are not at-risk, Zheng et al. (2014) found that laptops do help to narrow the achievement gap as measured by state Science test scores. Additionally, Serin (2011) found improved problem-solving skills for all students in Science which correlated to an increase in achievement for students and positive attitudes about Science in the 1:1 program. Overall, wrote Holcomb (2009), the evidence supports the conclusion that 1:1 laptop programs can and often do have a positive impact on Science achievement.

Mathematics Achievement

Research specific to the area of Mathematics is somewhat more common than the limited studies available in the area of Science. Of the findings available, no improvements were found in the Math scores of students in Peru (Cristia et al., 2012). A similar absence of Math gains on middle school standardized state tests was true of a study of 972 middle school students in a U.S. mid-Atlantic state (Dunleavy & Heinecke, 2007). When Addis and Falk (2010) looked at 1:1 laptop research between 2008 and 2010, results for Math achievement were mixed. Beebel and O'Dwyer (2010) found only modest gains in Math achievement relative to 1:1 programs.

Other authors, however, speak to the positive impact of 1:1 laptop programs on Mathematics achievement. Comparable to the effects on Science achievement, Freimana et al. (2010) suggested that access to computers also helps students develop problem-solving skills in Math. Hansen et al. (2012) added that the abstract reasoning skills needed for Math develop more easily with computer aided instruction. This same study showed that gains in Math scores for students with laptops, however, were not as apparent in the elementary grade levels as was observed in the middle grades. Math scores improved for laptop students in Chinese migrant worker schools (Mo et al., 2013) and similarly for economically disadvantaged students in an urban American school (Mouza, 2008). Argueta et al. (2011) found that Algebra scores and grades dropped in the first year of one laptop program, but corrected and then improved in the third year.

The integration of Mathematics instruction with laptop programs can be less natural than that of other subject areas. Silvernail and Gritter (2007) evaluated the massive middle school laptop program in Maine known as the Maine Learning Technology Initiative (MLTI), noting that of all disciplines, math classes used their laptops least frequent. Argueta et al. (2011) reminded the reader that a lack of integration and frequency of use have a direct effect on the impact of laptops on Math achievement. Overall, argued Holcomb (2009), Math scores associated with 1:1 laptop programs have been significantly higher in the United States, though the evidence associated with research is not as common as with Language Arts.

Language Arts Achievement

The largest and most productive category of research in the area of academic achievement as it relates to 1:1 laptop programs in schools has been in the Language Arts subject area. This could be due to the nature of Reading and Writing which are subjects that transition more naturally to computers. Reading from digital print does not require new skills and typing written assignments (word processing) is far from new to education. As a result, the most basic uses of laptops in Language Arts classes does not require professional development nor training for students. The research imbalance between Language Arts and other core subject areas could also help to explain why documented academic gains are more common in Language Arts (Sauers & Mcleod, 2012). State test scores on Maine’s state Writing test saw significant improvements following their statewide middle school laptop program (Silvernail & Gritter, 2007). This study also found that as laptops were used more, a parallel increase in Writing scores was observed. Holcomb (2009) also reviewed the research of 1:1 initiatives in

Maine along with that in Alabama, Michigan, South Carolina, Texas, New York, Virginia, Massachusetts, and Florida. This author pointed out that the impact across the country has been significantly positive, specifically in the area of Writing. Higher Writing test scores and grades, added Holcomb (2009), are typically correlated to increased amounts of time spent Writing, editing, and reflecting, all of which are associated with 1:1 laptop programs.

Addis and Falk (2010) found that while results were mixed in other subject areas, a general gain in Language Arts achievement is consistent across most studies. In fact, nearly all authors who report gains in academic achievement speak to the significant gains found in Language Arts, even when these same studies do not boast improvements in other subject areas. The only exceptions to this pattern would be the studies that look only at one subject area, such as Science, without consideration of any impact on Language Arts.

In the rare instances where improvements were not realized in Language Arts studies (as well as other areas), authors tend to point to problems associated with implementation, integration, and teaching practices as potential explanations. Cristia et al. (2012) found this to be the case in a comparison study of 319 rural public primary schools participating in the One Laptop Per Child program (OLPC) in Peru, where only40% of students were able to take their laptops home, Internet access was limited, and teaching practices were weak. Holcomb (2009) articulated similar findings related to teaching practices when looking at a failed laptop initiative in Texas.

Without question, however, positive academic gains in literacy skills is common among 1:1 laptop research (Bebell & Kay, 2010; Gulek & Demirtas, 2005; Lowther et al., 2003; Mouza, 2008; Suhr, Hernandez, Grimes, & Warschauer, 2010; Warschauer, 2007; Zheng, Warschauer, Lynch, & Chang, 2016). In one study, students in the laptop group performed significantly better than their fourth grade peers in Reading and Writing in what is known as the "fourth-grade slump," a phenomena observed when students transition from "learning to read" to "Reading to learn" (Suhr et al., 2010, p. 6). A Canadian study of students in grades five and six found that having laptops motivated students to read and write more (Canuel, 2010). Additionally, their Writing was more purposeful and reflective with an overall improvement in quality. A California middle school longitudinal study of 259 students also showed an improved quantity and quality of student Writing (Gulek & Demirtas, 2005). These results are mirrored by Sun, Yang, and He (2014) who found the same when comparing three fifth grade classes in China.

Warschauer (2007) illuminated the potential for literacy benefits when each student has their own laptop. These include students taking more responsibility for their learning (autonomy), processes that are more public and collaborative, having a more authentic purpose and audience, and a more fluid revision process which includes more feedback and scaffolding. Laptop students also have access to a host of literacy sources such as Google, online encyclopedias, databases, magazines, newspapers, journals and books. And student products are likewise more robust and diverse, including brochures, pamphlets, petitions, videos, websites, musical compositions, animations, and photo documentaries.

Comparing the four core subject areas, more 1:1 laptop research has been conducted in the areas of Language Arts and, to a lesser degree, Mathematics achievement than in Science and Social Studies achievement. The reason for this could be as simple as our focus on Reading and Math as the central components of the federal education mandate known as the No Child Left Behind Act (NCLB). As a result of this 14-year-old law, all U.S. states have been testing students in Reading and Math as a way to account for achievement, compare states, and grade schools (Klein & Camera, 2015). Many states have added tests in the areas of Science and Social Studies, but Reading and Math are the only subjects addressed in the national spotlight. Similarly, the original Elementary and Secondary Education Act (ESEA) of 1965 (part of President L.B. Johnson's War on Poverty) was reauthorized in 1994 to, among other things, assure that all adult Americans are literate. The 1983 report titled *A Nation at Risk* condemned schools, declared that we still had 23 million illiterate American adults (Mehta, 2013). As a result of this focus on literacy, we can see that learning to read and write has been our first and greatest national priority over the past 30 years where education is concerned, with subsequent legislative emphasis added to Math, and only a more recent amount of discussion given to Science, particularly with current STEM initiatives (Science, Technology, Engineering & Math).

Summary

A wide variation of laptop programs in schools continues to emerge as educators experiment with how to improve instruction and learning. The intent of these relatively new efforts is to immerse technology in the learning process in ways that individualize approach while maximizing achievement for all students. Unfortunately, and similar to the outcomes of many other major educational reform efforts, the implementation of 1:1 laptop programs has drawn so much attention to the logistics and mechanics of the program that administrators and teachers tend to lose sight of what they are actually trying to accomplish with students. Most 1:1 schools tend to plan for hardware, Wi-Fi infrastructure, policy, and initial funding. But, most schools also typically neglect the very real need for content-specific professional development focused on how teachers and students are to use the technology and to what end. Like some students with their laptops, we become so distracted by the technology that we forget what we are supposed to do with it.

Research has been around for decades speaking to the evidence associated with the success of student-centered best instructional practices. These include constructivist strategies, collaborative learning, peer review, differentiation, project or problem-based learning, and formative assessments. At the same time, we know that 21st Century students need to develop critical thinking skills, the ability to apply what they know in the real world, strategies for navigating the enormous and growing amount of information available with the internet, and a strong general facility with using information and communication technologies (Lowther, Inan, Ross, & Strahl, 2012). All of these need to be accounted for when designing professional development goals for teachers. More often than not, however, these pieces of the puzzle are missing when laptop programs are deployed.

This apparent problem with integration and teacher preparation may help to explain why the research available reflects inconsistent and even contradictory findings when evaluating the success of 1:1 laptop programs. This is true for studies looking at student engagement and behavior as well as measures of student achievement within and across subject areas. A number of additional contextual factors reportedly influence a laptop program's success. These include maintenance plans, long-term budgeting, the frequency of use in the classroom, strong leadership, and attention to the complexities inherent in the change process. And since we know that the classroom teacher bears the greatest burden for implementing 1:1 laptop programs, it is not surprising that teacher attitudes, professional development, and an ongoing support for teachers significantly affect a program's success.

Yet in spite of the shortcomings noted, findings are beginning to show evidence that 1:1 laptop programs do have the potential to revolutionize the educational process, producing significant gains in student achievement (Zheng et al., 2016). A number of studies show improvement in achievement scores across subject areas, with the greatest and most consistent gains in Language Arts. Some of the most promising results are among students with learning disabilities and other at-risk students. And while most studies evaluate laptop program impacts on state achievement scores, their greatest benefit may be the cultivation of 21st century skills, which are not measured by these tests.

There are authors who argue that the evaluation of the cost versus the benefit of 1:1 laptop programs does little to justify the investment. Others counter with the charge that today's students must have anywhere and anytime access to the world of information made available with the internet. They liken the sharing a limited number of immobile computers to the notion of students sharing five pencils that cannot leave the classroom. Unquestionably, ours is an exciting time of transition in the evolution of education. Many, many questions remain to be answered as we tarry down the path of 21st century educational reform.

To this end, this study will need to better provide context in evaluating relationships between the 1:1 program and achievement test results. To begin understanding the reasons for such a wide array of successes and failures, a thorough discussion of the contextual factors surrounding a program must be imbedded in the study.

CHAPTER III

METHODOLOGY/PROCEDURES

Introduction

The purpose of this study is to better understand the relationship between the 1:1 laptop program and student achievement at one rural Ohio high school when considering 2014 and 2015 student scores on the Ohio Graduation Test (OGT). Utilizing the theoretical constructs of the reviewed literature and state achievement test data, measures are compared to examine the difference, if any, between OGT scores of students receiving traditional instruction prior to implementing the laptop program (2014 tenth graders) and students receiving instruction using individual laptops and electronic textbooks (2015 tenth graders).

This chapter describes the research design, methods, and procedures used. Included are the conceptual framework, research design, research questions, and research hypotheses. In addition, sampling procedures, data collection and instrumentation are presented. And finally, the chapter discusses the data analysis and limitations of this study.

Research Design

Conceptual Framework

The Conceptual Framework steering this analysis is the comparison of state test scores between traditional and digital pedagogic instructional practices. Jeffery James (2010) is perhaps most assertive in his criticism of the laptop movement, contending that the studies of laptop programs over the past 20 years have not borne results that support the economic burden to schools, which are already struggling financially. James (2010) is certainly not alone, as many researches do indeed find various 1:1 programs to fall short of expectations, showing little if any positive impact on student achievement. The author further questions the validity of some proponent research which is supported by companies that ultimately benefit from laptop sales to schools.

Weston and Baine (2010) criticized the implementation process typically used in educational reform as setting up 1:1 programs for failure. These authors contended that while many laptop programs fail, the reason is no different than that for the failure of numerous other education reform efforts. A weak implementation approach almost guarantees that programs, such as 1:1 laptop initiatives, will not accomplish their goals and then be abandoned.

One of the great voices of technology integration in education, Alan November, asserted that to meet the goals of improved learning in the 21st century, we have to go beyond 1:1 laptop programs to clearly define pedagogical best practices and prepare teachers for how the devices will be used. Simply giving students laptops will not achieve our aims. November is a strong advocate for integrating technology in schools, arguing that there is a critical need for students to have access to the vast amount of information and learning supports afforded by the internet. The author warns, however, that we consistently waste time and money when we become distracted by the device and forget what it is we want students to learn.

Finally, the analysis herein is also guided by research which suggests that in spite of the barriers, laptop programs can raise student achievement. And under the right conditions, 1:1 laptop programs afford the greatest potential to date for reforming education. Specifically, gains in student achievement are most commonly found in the content area of language arts and among typically underperforming subgroups of students such as those who are economically disadvantaged.

Education is unquestionably in a period of rapid and tumultuous change. With mixed results and varying philosophical leanings relative to 1:1 laptop programs, the question still remains: Does the investment yield the desired results of improving student learning?

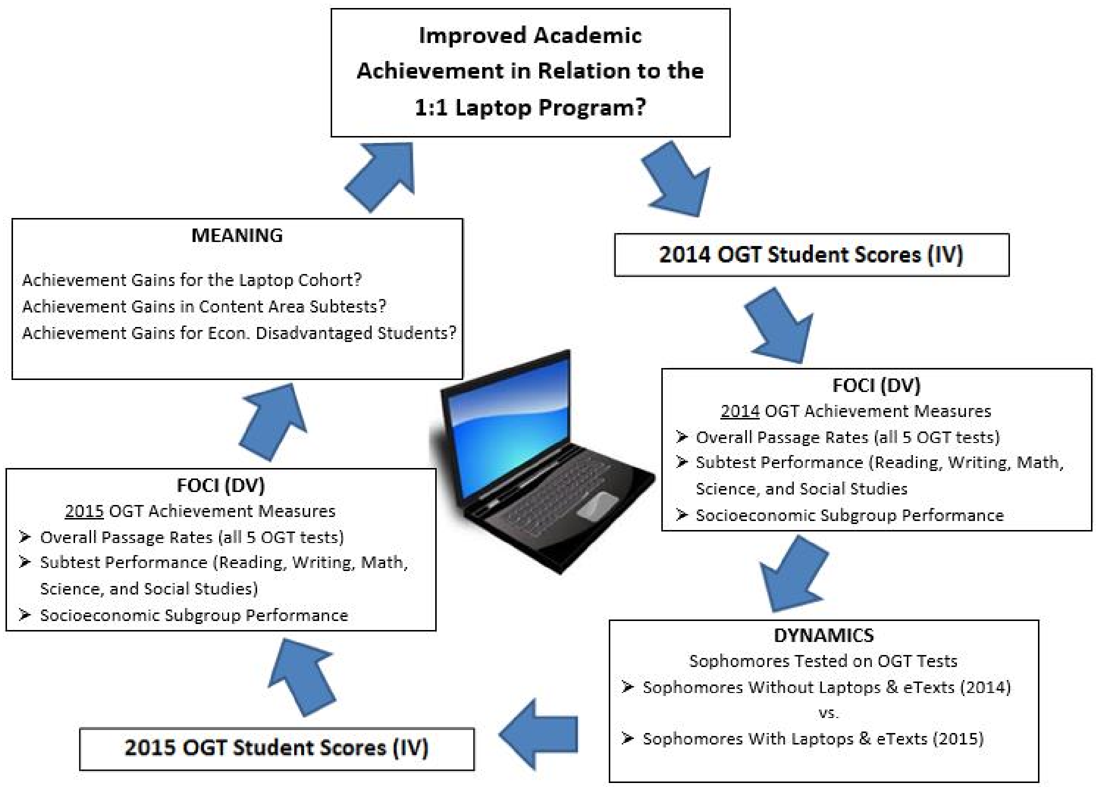

Figure 1. Conceptual framework.

A **quasi-experimental ex post facto design** is employed in this quantitative study as participants are not randomly assigned and since the characteristics of participants are not manipulated. Or as Cohen, Manion, and Morison (2000) explained, as opposed to using randomized groups with the same characteristics and exposing them to multiple treatments to uncover differences among dependent variables, the ex post facto design looks at groups (independent variables) that are already specifically different, (one with laptops and one without), seeking to understand (after the fact) the factors that might have impacted those differences. Sukhia, Metrotra, and Metrotra (1966) provide the foundational logic underscoring the ex post facto method (also known as causal comparative method):

> This method is based on Mill's Cannon of Agreement and Disagreement which states that causes of a given observed effect may be ascertained by noting elements which are invariably present when the result is present and which are invariably absent when the result is absent. (p. 215)

Several benefits can be found in support of the ex post facto method. First, it allows for the study of relationships when it is not possible to select, control, and manipulate participants in ways that directly determine cause and effect. Second, it illuminates the nature of a phenomenon, helping to explain what is going on, under which conditions, and with which patterns might exist. And third, the use of statistical methods providing partial controls add legitimacy to the ex post facto method (Isaac & Michael, 1995).

While the ex post facto method allows us to study humans in ways that may not be possible or ethical using a true experimental design, limitations must be acknowledged. First, it is difficult if not impossible to establish a true cause and effect relationship because the data is received after the fact, without the ability to control independent variables. There is no opportunity to arrange conditions or engineer the variables that impact the data. As a result, we cannot consider and eliminate all other possible explanations. Second, and related to the first, is the difficulty in knowing that our study includes the most relevant causational factor. This method is further complicated by the reality that outcomes (particularly in the social sciences) are actually the product of multiple factors which interact and under certain conditions produce an outcome. A fourth weakness recognizes that an outcome may be the result of one cause considering one participant and another cause with a different participant. And finally, ex post facto methods do not allow for the control of the process of selecting participants (Isaac and Michael, 1995).

In short, ex post facto studies have limitations and as a result are inclined to produce findings that are not precise and reliable in the way experimental studies typically are. This method is also limited in that its findings are situationally suggestive, making it difficult to generalize findings. It does, however, provide a pathway for exploring problems that cannot be dissected in a laboratory setting. The power of these ex post facto studies is found in the clues uncovered in our attempts to understand the nature of a phenomenon.

Considering the limitations mentioned, the research questions can only be answered in terms of relationships (correlational) as opposed to causes. Applying these limitations to this study, it is important to note that we are not attempting to determine if the 1:1 laptop program causes students to earn better scores on the Ohio Graduation Test. Rather, we are hoping to determine the strength of relationship between the laptop program and student scores.

Research Questions

Three (3) research questions are addressed in this study:

Question (1) Do participants in the laptop program (2015 tenth graders) perform better than non-participants (2014 tenth grades) on the OGT? This first question employs a comparison of total (overall) achievement of the two groups (independent variable) using each student's total score for all five subtests (dependent variable). Total scores were calculated by the researcher, as data from the Ohio Graduation Test do not provide any type of a composite or total score. The only overall data provided are the percentages of students who passed all five OGT tests. A **one-tailed *t*-test** for independent means is used for statistical analysis in examining the difference between the total scores for each student in the two cohorts (IV: laptops and eTexts / no laptops and eTexts).

Question (2) Does participation in the 1:1 laptop program (IV) significantly affect OGT Reading, Writing, Math, Science, and Social Studies student achievement scores, among 10^{th} grade students after adjusting for 8^{th} grade Reading, Writing, Math, Science, and Social Studies OAA scores? This second question looks to see if there is a difference between the two groups (independent variable) within each of the five subtests (dependent variables): Reading, Writing, Math, Science, and Social Studies. For this question, a multiple analysis of variance is generated using a one way **MANOVA** (multivariate analysis of variance).

Question (3) Does participation in the 1:1 laptop program affect OGT scores in Reading, Writing, Math, Science, and Social Studies among 10^{th} grade economically disadvantaged students? This subgroup of students in the 2015 laptop cohort is compared with the entire no laptop cohort (2014) and also with the economically disadvantaged subgroup in the no laptop cohort (2014). A **MANOVA** (multiple analysis of variance) is used to determine the gain of scores for students identified as economically disadvantaged.

Used in this study, the research design is aided by quantitative data and by specific research hypotheses. Research hypotheses were developed using findings for both logical and empirical data. Data for analysis were retrieved from the 10th grade score results of the 2014 and 2015 Ohio Graduation Tests as reported by the Ohio Department of Education. A visual overview of the research design is provide (Figure 1) and multiple equations are to demonstrate the specific relationships among variables investigated.

Framework of Assumptions

1. Total Score Assumption (A): Students' Total Scores/TS (combined across the five subject areas) for the 2015 OGT (Laptops/L) will be greater than the Total Scores/TS for the 2014 OGT (No Laptops/NL).

A. (L)TS > (NL)TS

⇨ [OGT15 (R+W+M+SC+SS) > OGT14 (R+W+M+SC+SS)]

2. Subject Area Assumptions (B-F): For each subject area (Reading, Writing, Math, Science and Social Studies), the OGT scores of 2015 students (Laptops/L) will be greater than the OGT scores of the 2014 students (No Laptops/NL).

B. (L)OGT15R > (NL)OGT14R

C. (L)OGT15W > (NL)OGT14W

D. (L)OGT15M > (NL)OGT14M

E. (L)OGT15S > (NL)OGT14S

F. (L)OGT15SS > (NL)OGT14SS

3. Economically Disadvantaged Students Assumptions (G-P): For each subject area (Reading, Writing, Math, Science and Social Studies), the OGT scores of 2015

Economically Disadvantaged students (Laptops/L) will be greater than the OGT scores of the 2014 cohort (No Laptops/NL), including all students regardless of economic disadvantage status. Also for each subject area, the OGT scores of 2015 Economically Disadvantaged students (Laptops/L) will be greater than the OGT scores of the 2014 Economically Disadvantaged students (No Laptops/NL).

G. (L)OGT15R(ED) > (NL)OGT14R H. (L)OGT15R(ED) > (NL)OGT14R(ED)	**Reading**
I. (L)OGT15W(ED) > (NL)OGT14W J. (L)OGT15W(ED) > (NL)OGT14W(ED)	**Writing**
K. (L)OGT15M(ED) > (NL)OGT14M L. (L)OGT15M(ED) > (NL)OGT14M(ED)	**Math**
M. (L)OGT15S(ED) > (NL)OGT14S N. (L)OGT15S(ED) > (NL)OGT14S(ED)	**Science**
O. (L)OGT15SS(ED) > (NL)OGT14SS P. (L)OGT15SS(ED) > (NL)OGT14SS(ED)	**Social Studies**

Description of Contextual Factors

In an attempt to better understand the strength of relationship between the 1:1 laptop program at this high school and the school's Ohio Graduation Test scores, a three-part analysis was constructed to describe contextual factors that may or may not account in part for any degree of difference in OGT scores between the laptop group (2015 tenth graders) and the non-laptop group (2014 tenth graders). First, a look at how each group of 10th graders performed on their most previous state assessment (the eighth grade Ohio Achievement Assessment) will help to show how the two cohorts of students compare on a test that was not impacted by the 1:1 laptop program. Data provided by the state of Ohio was compiled for this analysis (Ohio Department of Education, 2013a; Ohio Department of Education 2015). Second, a five-year trend analysis of how OGT scores at the state and county levels compare to those at the high school studied will help to understand if any change in OGT scores from 2014 to 2015 is part of a broader trend. Data retrieved for this analysis were downloaded from the state website (Ohio Department of Education, 2015). To be able to suggest that the new 1:1 laptop program has impacted the scores for the 2015 tenth graders, the scores would need to exceed the predicted expectations based on the trend analysis. And third, a narrative analysis comparing instructional contexts (teachers, standards, curriculum, and resources) for the two groups of 10th graders at the school will help to explain other factors related to student OGT scores which may or may not have influenced those OGT scores.

OGT and Prior OAA Performance

The first analysis looks at how these two groups of students performed on pervious state assessments, comparing their 8^{th} grade Ohio Achievement Assessment (OAA) performance levels to those of the 10^{th} grade OGT. In Ohio, the most previous comparable assessments for the 2014 and 2015 tenth graders are at the eighth grade level. These eighth grade assessments, however, only test in the areas of Reading, Mathematics, and Science. As such, these three subject area tests are used in comparing the performance of the same students to their corresponding OGT test scores. Table 1 illustrates the Reading assessments comparison:

Table 1

OAA & OGT Reading Score Comparison: Laptop Cohort (2015 Tenth Graders)

2017 Graduating Class Grade 8 OAA Performance in 2013					2017 Graduating Class Grade 10 OGT Performance in 2015				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 450)	37	40.2	94.6	Proficient or Above	Advanced (> 447)	13	14.8	96.6
	Accelerated (428-450)	31	33.7			Accelerated (429-447)	37	42	
	Proficient (400-428)	19	20.7			Proficient (400-428)	35	39.9	
Below Proficient	Basic (378-399)	5	5.4	5.4	Below Proficient	Basic (383-399)	2	2.3	3.4
	Limited (< 378)	0	0			Limited (< 383)	1	1.1	
Totals		92		100%	Totals		88		100%

When looking at the percentage of students who passed these two tests (Proficient or Above) and considering that these are the same students (graduating class of 2017), we can see an increase of two percentage points in the passage rate on the tenth grade OGT for the 1:1 laptop group (2015 tenth graders) as compared to their corresponding eighth grade OAA passage rate (Table 1). While arguably less than significant, this is still an increase in the passage rate. Perhaps more significant, however, are the interior scores for performance levels. Here the chart reflects that scores have dropped from 40.2% to 14.8% in the Advanced level within the Proficient category. It is also important to note that the OAA tests only eighth grade standards while the OGT tests standards for grades nine and ten. Still, the data provided in this analysis show that on the OGT, 24 fewer students fall into the Advanced level while 2 less students are in the Below Proficient category for the tenth graders participating in the 1:1 laptop program as compared to their scores on the OAA.

Table 2 also looks a Reading score levels, but this time comparing the OGT scores for the group that did not participate in the 1:1 laptop program (2014 tenth graders) to the scores those same students received when they took their eighth grade OAA. For the group of students not participating in the 1:1 laptop program, the increase in passage rates between the eighth grade Reading OAA and the corresponding grade 10 OGT is slightly greater with a difference of 3.5 percentage points. Similar to the laptop group, interior numbers suggest that the greatest improvement occurs in moving students from the Below Proficient level to the Proficient level, while fewer students, this time only 4, placed into the Advanced category.

Taking both charts into account, however, it appears that there is a nominal increase in passage rates (proficient or above) that occurs from eighth grade to tenth grade assessments for both groups of students regardless of the 1:1 laptop program when considering Reading scores.

Table 2

OAA & OGT Reading Score Comparison: No Laptop Cohort (2014 Tenth Graders)

2016 Graduating Class Grade 8 OAA Performance in 2012					2014 Graduating Class Grade 10 OGT Performance in 2014				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 450)	18	16.3	88.3	Proficient or Above	Advanced (> 448)	14	14.8	91.8
	Accelerated (428-450)	44	39.6			Accelerated (429-447)	28	42	
	Proficient (400-427)	36	32.4			Proficient (400-428)	59	39.9	
Below Proficient	Basic (378-399)	12	10.8	11.7	Below Proficient	Basic (383-399)	6	2.3	8.2
	Limited (< 378)	1	0.9			Limited (< 383)	3	1.1	
Totals		111		100%	Totals		110		100%

Table 3 compares results for the 2013 Math OAA to the 2015 Math OGT:

Table 3

OAA & OGT Math Score Comparison: Laptop Cohort (2015 Tenth Graders)

2017 Graduating Class Grade 8 OAA Performance in 2013					2017 Graduating Class Grade 10 OGT Performance in 2015				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 458)	15	16.3	85.9	Proficient or Above	Advanced (> 443)	44	50.0	93.2
	Accelerated (432-458)	29	31.6			Accelerated (425-443)	17	19.3	
	Proficient (400-431)	35	38.0			Proficient (400-424)	21	23.9	
Below Proficient	Basic (379-399)	12	13.0	14.1	Below Proficient	Basic (384-399)	3	3.4	6.8
	Limited (< 379)	1	1.1			Limited (< 384)	1	3.4	
Totals		92		100%	Totals		88		100%

Table 3 suggests a substantial increase of the passage rate for the tenth grade OGT when compared to the eighth grade OAA for the same group of students. In this data set, we see not only a 7.3 point increase in the percentage of students indicated as proficient, but we also see an increase of 33.7 points for the percentage of students who scored in the Advanced level of the Proficient category. For the OAA, 16.3% of the students scored in the Advanced category and for the OGT, 50% of these same students scored in the Advanced category. And as compared to 14.1% of the students (13) being Below Proficient on the OAA, only 6.8% (6) are Below Proficient on the OGT.

Table 4 explores the same comparison of Math Performance Levels for the non-laptop group of students (2014 OGT tests):

Table 4

OAA & OGT Math Score Comparison: No Laptop Cohort (2014 Tenth Graders)

2016 Graduating Class Grade 8 OAA Performance in 2012					2014 Graduating Class Grade 10 OGT Performance in 2014				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 458)	4	3.6	94.6	Proficient or Above	Advanced (> 443)	33	30.0	96.6
	Accelerated (432-458)	31	27.9			Accelerated (425-443)	35	31.8	
	Proficient (400-431)	59	53.2			Proficient (400-424)	29	26.4	
Below Proficient	Basic (379-399)	14	12.6	5.4	Below Proficient	Basic (384-399)	8	7.3	3.4
	Limited (< 379)	3	2.7			Limited (< 384)	5	4.5	
Totals		111		100%	Totals		110		100%

Table 4 shows that the pattern holds true for increased passage rates and scores of the no laptop group for the OGT as compared to the OAA. With Math scores, however, the increase in the percentage of students at the Proficient level for the 1:1 laptop group is more than double that of the increase observed for the no laptop group. Table 4 also shows that is a very significant increase in the interior scores for the Advanced level. For the no laptop students, the increase is 26.4 percentage points. For the 1:1 laptop group, however, the increase was 33.7 percentage points. While both groups show significant growth from the OAA to the OGT in Math, based on this data, the 1:1 laptop program group (2015 tenth graders) saw a greater improvement in Math OGT scores.

Table 5 reflects the comparison of eighth grade OAA Science scores to the scores of the laptop group for the tenth grade OGT Science test:

Table 5

OAA & OGT Science Score Comparison: Laptop Cohort (2015 Tenth Graders)

2017 Graduating Class Grade 8 OAA Performance in 2013					2017 Graduating Class Grade 10 OGT Performance in 2015				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 444)	27	29.4	85.9	Proficient or Above	Advanced (> 444)	25	28.4	86.3
	Accelerated (427-444)	21	22.8			Accelerated (425-444)	17	19.3	
	Proficient (400-426)	31	33.7			Proficient (400-424)	34	38.6	
Below Proficient	Basic (365-399)	12	13.0	14.1	Below Proficient	Basic (371-399)	10	11.4	13.7
	Limited (< 365)	1	1.1			Limited (< 371)	2	2.3	
Totals		92		100%	Totals		88		100%

Table 5 shows OGT scores having a very small increase in passage rates of only .4 percentage points with interior Performance Levels remaining relatively consistent. Table 6 makes the same comparison of OAA and OGT Science performance for the no laptop group of students (2014 tenth graders):

Table 6

OAA & OGT Science Score Comparison: No Laptop (2014 Tenth Graders)

2016 Graduating Class Grade 8 OAA Performance in 2012					2014 Graduating Class Grade 10 OGT Performance in 2014				
Performance Level		# Tested	Percent		Performance Level		# Tested	Percent	
Proficient or Above	Advanced (> 444)	21	18.9	84.7	Proficient or Above	Advanced (> 444)	27	24.5	87.3
	Accelerated (427-444)	28	25.3			Accelerated (425-444)	30	27.3	
	Proficient (400-426)	45	40.5			Proficient (400-424)	39	35.5	
Below Proficient	Basic (365-399)	15	13.4	15.3	Below Proficient	Basic (371-399)	12	10.9	12.7
	Limited (< 365)	2	1.8			Limited (< 371)	2	1.8	
Totals		111		100%	Totals		110		100%

Looking at the no laptop group (Table 6), the increase in scores for the 2014 OGT students is greater than the increase reflected in Table 5 for the laptop group. In fact, the percent Proficient or Above on the OGT decreased from 87.3% in 2014 to 86.3% in 2015.

This first part of the contextual factors discussion looked at previous performance on OAA scores to compare how the same groups of students performed in eighth grade and then later in tenth grade. This initial analyses shows that the 1:1 laptop program has a weak yet positive relationship with Reading performance, a strong positive relationship with Math performance, and a marginally negative relationship with Science performance.

Table 7 provides a summary comparison of the passage rates for the laptop and no laptop cohorts on the eighth grade OAA and tenth grade OGT.

Table 7

Summary Comparison of Passage Rates

Cohort	Grade 8 OAA Math	Grade 10 OGT Math	Grade 8 OAA Science	Grade 10 OGT Science	Grade 8 OAA Reading	Grade 10 OGT Reading	Grade 8 OAA Average	Grade 10 OGT Average
Laptop	88.9	93.2	85.9	86.3	94.6	96.6	89.8	92.0
No Laptop	84.7	88.2	84.7	87.3	88.3	91.8	85.9	89.1

In short, the Math passage rate for the eighth grade OAA was 4.2 percentage points higher for the laptop cohort as compared to a 5% increase in the passage rate for the OGT. For the laptop cohort in Science, there was a 1.2 percentage increase on the OAA but a decrease of 1 percentage point for the OGT. And in Reading, the laptop cohort outperformed the no laptop cohort by 6.3 percentage points on the OAA and by 5.2 percentage points on the OGT.

Local, County, and State Five-Year Trends

Part two of the contextual description provides a 5-year trend analysis for each subject area test to consider how the school's 2015 1:1 laptop group (taking the OGT in 2015) compares to trends at the state and county levels.

Table 8

Five-Year Trend Analysis of OGT Scores for Reading

	Percentage at or Above Passing				
	2011	2012	2013	2014	2015
Ohio Public Schools	87.8	86.4	88.3	89.4	85.5
Columbiana County Public	87.3	86.4	88.0	89.4	88.5
High School Studied	93.2	90.0	90.3	91.8	96.6

Table 8 addresses this analysis by comparing passage rates for the OGT Reading test. The corresponding Figure 2 illustrates that with the 2015 administration of the OGT, both state and county passage rates declined while the laptop group at the school studied saw its passage rate rise by nearly five percentage points. Further, for the four years prior to the 2015 OGT, the trajectory of passage rates was very similar between the local, county, and state passage rates. This high school, however, saw passage rates increase from 2014 to 2015 by 4.8 percentage points while both the county and state passage rates dropped for the same year.

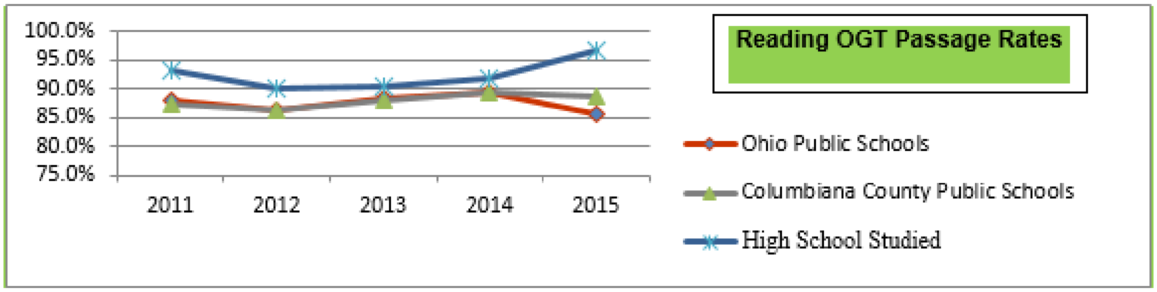

Figure 2. Five-year trend analysis of OGT scores for Reading.

Table 9

Five-Year Trend Analysis of OGT Scores for Writing

	Percentage at or Above Passing				
	2011	2012	2013	2014	2015
Ohio Public Schools	90.1	87.5	85.3	88.0	85.5
Columbiana County Public	90.7	85.7	87.4	89.7	88.2
High School Studied	93.2	87.9	86.4	87.3	92.0

Similar to the trends for Reading passage rates, Writing scores (Table 9 and Figure 3) also indicate a parallel trajectory until 2015, when the 10th graders tested at the studied high school were participants in the 1:1 laptop program. Here again, both county and state passage rates declined from 2014 to 2015 while the passage rates for the students at this high school increased.

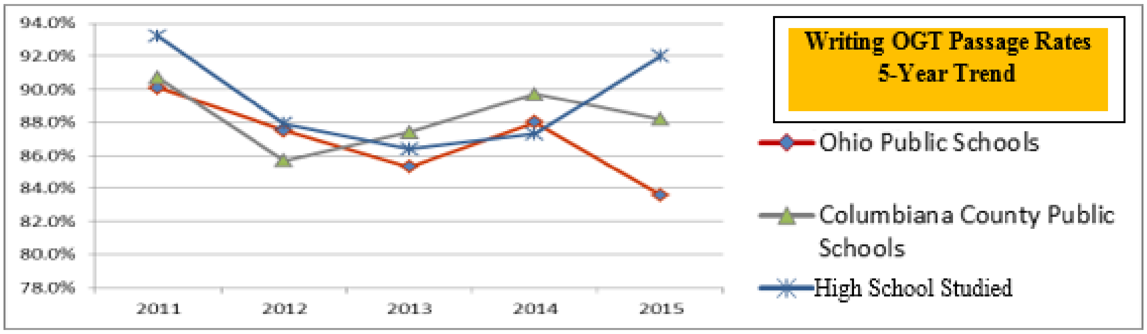

Figure 3. Five-year trend analysis of OGT scores for Writing.

Table 10

Five-Year Trend Analysis of OGT Scores for Math

	Percentage at or Above Passing				
	2011	2012	2013	2014	2015
Ohio Public Schools	83.2	83.2	84.6	82.3	81.0
Columbiana County Public	81.4	82.3	86.2	82.3	85.5
High School Studied	84.1	85.9	89.3	88.2	93.2

For the previous comparison of OAA and OGT passage rates (Table 3), the most notable gains were with the Math tests (a 7.3% increase for the laptop group). The 5-year trend analysis shown in Table 10 indicates an increase in passage rates for the high school's laptop group that is similar yet greater than that of the county and even more so when compared to the state passage rates. Once again, state passage rates show a drop-off from the 2014 passage rates.

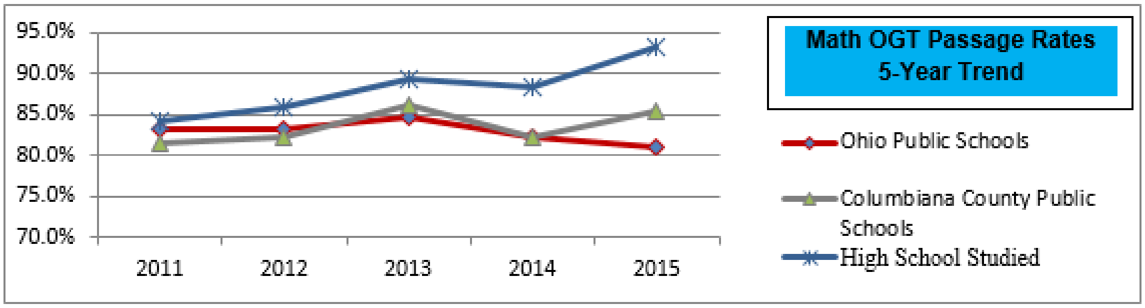

Figure 4. Five-year trend analysis of OGT scores for Math.

Table 11

Five-Year Trend Analysis of OGT Scores for Science

	Percentage at or Above Passing				
	2011	2012	2013	2014	2015
Ohio Public Schools	75.0	77.0	77.9	77.4	73.3
Columbiana County Public	75.7	78.6	79.4	78.7	78.0
High School Studied	86.4	84.9	79.6	87.3	86.3

Table 11 and Figure 5 illustrates the loss of one percentage point in 2015 following a 7.7 percentage point gain realized from 2013 to 2014 for Science passage rates. And while the studied school saw a one percentage point drop-off, the county passage rates similarly fell by .7 percentage points and the state as a whole saw passage rates for the Science OGT decrease by 4.1percentage points. All considered, the county and state were consistent with a decline of Science passage rates when compared to Reading, Writing, and Math scores. The Science passage rate trajectory at this school parallels that of the county and state. However, it is inconsistent with the previous three subject tests for this high school, where passage rates increased instead of decreasing along with county and state passage rates.

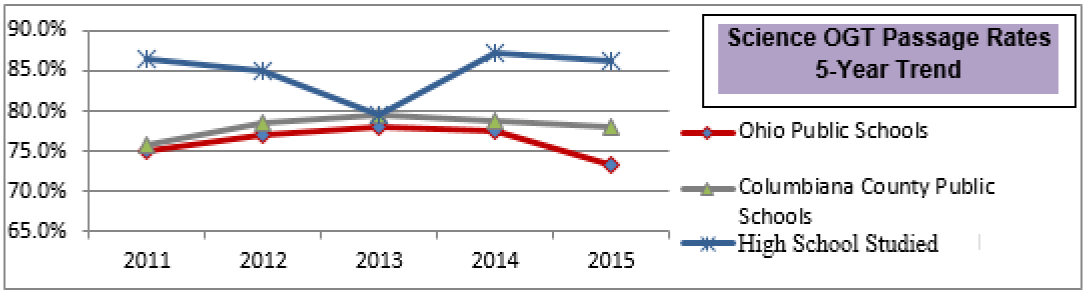

Figure 5. Five-year trend analysis of OGT scores for Science.

Table 12

Five-Year Trend Analysis of OGT Scores for Social Studies

	Percentage at or Above Passing				
	2011	2012	2013	2014	2015
Ohio Public Schools	80.5	82.1	81.7	82.9	80.2
Columbiana County Public	77.8	83.0	82.9	83.0	82.9
High School Studied	89.8	84.8	83.5	91.0	89.8

Similar to Writing, there are no eighth grade Social Studies OAA tests to compare passage rates to the Social Studies OGT. Looking at the 5-year trend analysis for Social Studies OGT passage rates (Table 12 and Figure 6), however, we see a decline of 1.2 percentage points in the passage rate for the 2015 laptop group when compared to the 2014 no laptop group. And similar to Science, this decline follows a jump from 2013 to 2014 passage rates.

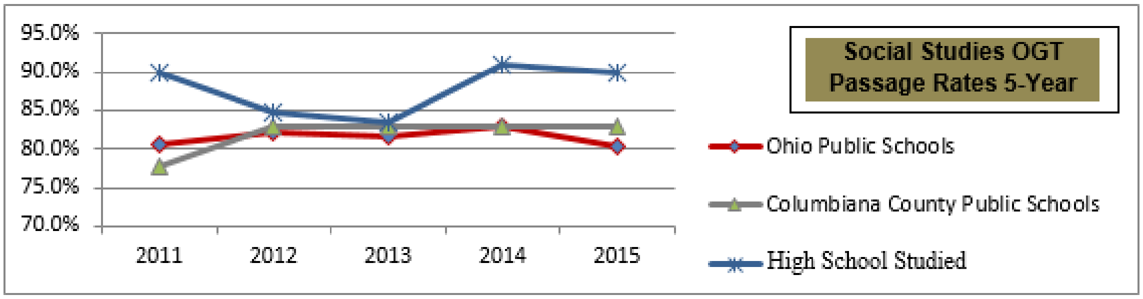

Figure 6. Five-year trend analysis of OGT scores for Social Studies.

For this high school, the Social Studies passage rate trajectory is similar to that of the county and state when making 2014 and 2015 comparisons. What stands out is that as with the Science OGT test, something happened between 2013 and 2014 which affected a spike in Social Studies passage rates at the school and these increased passage rates were fully sustained in 2015, in spite of the laptop program.

Instructional Factors

Part three of this contextual narrative investigates factors that are not as quantifiable as are the state assessment scores. Described herein are the curriculum and standards taught, teachers, and training. Considering first the curriculum and standards taught, it is important to note that Ohio has been in a transitional period, moving toward new state assessments and a Common Core curriculum. Both 2014 and 2015 tenth graders, however, fall under the old standards and both groups of students took the traditional OGT assessments. The 2015 tenth graders (graduating class of 2017) were the last group of students to take the OGT. All subsequent graduating classes in Ohio will be taking new online assessments, which were introduced to Ohio ninth graders in 2015. In 2015, these new assessments (AIR – American Institutes for Assessment and PARCC - Partnership for Assessment of Readiness for College and Careers) were administered to ninth graders. While in transition, schools have been instructed by the state to teach the standards that were established for both assessments. This same set of instructions was followed for the 2014 tenth graders and the 2015 tenth graders. For all testing to take place in 2016, only the new standards will be taught. In short, both 2014 and 2015 tenth graders were taught the same curriculum based on the same standards. As such, the content taught was the same for both the no laptop group and also the laptop group. The only difference was the delivery method whereby the laptop group used laptops and electronic textbooks, while the no laptop group used traditional hardbound textbooks and did not have laptops provided. This difference is solely connected to the 1:1 laptop program.

Looking at teachers of courses corresponding to the OGT tests, all students in both groups were taught by the same teachers, with the exception of the Science subject area. For Science, two factors may have impacted student performance. First, the special education teacher instructing three of the most cognitively delayed students in Science was new. This teacher was hired following retirement of the teacher who taught this sub population of students who took the OGT in 2014. And second, the Science teacher who taught all other 10th grade students was on an extended maternity for the majority of the months leading up to the 2014 administration of the OGT. This teacher returned for a full year of instruction prior to the 2015 OGT testing. As a result, 2014 tenth graders had two different substitute teachers for their Science class instruction during the months leading up to the March test administration. Ironically, the 2014 10th graders outperformed 2015 tenth graders on the Science OGT, showing a passage rate of one percentage point higher, in spite of having two substitute teachers over the course of the school year and regardless of 2015 tenth graders being involved in the laptop program.

Training provided for the teachers implementing the 1:1 laptop program was the same for those teaching Reading, Writing, Math, and Social Studies. Training included an on-site basic overview that was specific to the company providing the eText adopted. For Math and Social Studies, teachers were oriented to the Pearson-Prentice Hall eTexts (access, set-up, digital platform, and content). English teachers (Reading and Writing) received similar training oriented to the Holt-McDougal eTexts. For Science, however, the teacher on an extended maternity leave was not able to participate in trainings provided. For the other four subject area tests, all teachers and training provided were the same for both groups of students.

And finally, 2015 tenth graders who took the Social Studies OGT also had to take the new online AIR assessments in both of two separate testing sessions. While these tests did not count toward their graduation requirements, all 10th grades in the state of Ohio were required to take the “interim” Social Studies tests as a pilot assessment in addition to the OGT Social Studies assessment required for graduation (Ohio Department of Education, 2013). Social Studies was the only content area where the interim assessments were required and it was administered in February, only weeks prior to the Social Studies OGT administration. Students also had to take regular assessments for their class grades which were near the end of the grading term. And in the sequence of tests administered during OGT week, the Social Studies OGT takes place on Friday and is the last of the five tests administered. As 10th the grade Social Studies teacher explained, ". . . students were a little burnt out on testing by the time they got to the Social Studies OGT" (personal communication, March 21, 2015).

In summary, while there were some extenuating circumstances relative to the teachers involved in the instruction of Science and Social Studies classes, the teaching and instruction for Reading, Writing, and Mathematics instructional factors were consistent among both the 2014 and 2015 groups taking the Ohio Graduation Tests.

Research Hypotheses

There is variety of literature portraying mixed results when evaluating the impact of 1:1 laptop programs in schools. A growing number of those studies are indicating that under the right conditions, a significant and positive impact on achievement can be realized. Research summarized in Chapter 2 suggests the importance of considering specific content areas when attempting to measure potential achievement gains. As a result of an a priori interest in the relationship between subject area test scores, this study will also investigate the potential interaction among subject area scores comparing Reading and Writing, Reading and Social Studies, Writing and Social Studies, and Math and Science. This study will also take into account the subgroup variable of economically disadvantaged students (ED). As the sample population considered in this school setting has an inadequate percent of its students in a racial/ethnic minority subgroup (2014 n=2 or <1% and 2015 n=2 or 2%), we cannot consider the variable of race/ethnicity minority for statistical purposes. Likewise, while the subgroup of students identified with learning disabilities in included in the sample, this study does not address this subgroup for analysis as the size (2014 n=12 or 11% and 2015 n=7 or 8%) is also too small for statistical representation and comparison.

The review of literature tells us that while some studies have found achievement gains across content areas, the most significant and consistent gains are in the subject areas of Reading and Writing. This is in part because more studies have focused on the area Language Arts, neglecting the areas of Math, Science, and Social Studies. And as the research also indicates, Language Arts courses tend to use their laptops more often in class. Frequency of laptop use has been found to be indisputably associated with the degree of achievement gains realized. The research also suggests that students who are at-risk due to their socioeconomic status are more likely to see significant gains in achievement in correlation to laptop programs.

Given the current understanding of the research available, the following research hypotheses have been employed:

Null Hypothesis (1): There is no relationship between the initiation of the 1:1 laptop program (laptops and electronic textbooks for each student) and the Ohio Graduation Test scores. Alternate Hypothesis (1): There is a relationship between the initiation of the 1:1 laptop program (laptops and electronic textbooks for each student) and the Ohio Graduation Test scores.

Null Hypothesis (2): There is no relationship between the 1:1 laptop program (laptops and electronic textbooks for each student) and content area subtest scores. Alternate Hypothesis (2): There is a relationship between the 1:1 laptop program (laptops and electronic textbooks for each student) and content area subtest scores.

Null Hypothesis (3): There is no interaction between Reading and Writing scores for the no laptop cohort (NL). Alternate Hypothesis (3): There is an interaction between Reading and Writing scores for the no laptop cohort (NL).

Null Hypothesis (4): There is no interaction between Reading and Writing scores for the laptop cohort (L). Alternate Hypothesis (4): There is an interaction between Reading and Writing scores for the laptop cohort (L).

Null Hypothesis (5): There is no interaction between Reading and Social Studies scores for the no laptop cohort (NL). Alternate Hypothesis (5): There is an interaction between Reading and Social Studies scores for the no laptop cohort (NL).

Null Hypothesis (6): There is no interaction between Reading and Social Studies scores for the laptop cohort (L). Alternate Hypothesis (6): There is an interaction between Reading and Social Studies scores for the laptop cohort (L).

Null Hypothesis (7): There is no interaction between Writing and Social Studies scores for the no laptop cohort (NL). Alternate Hypothesis (7): There is an interaction between Writing and Social Studies scores for the no laptop cohort (NL).

Null Hypothesis (8): There is no interaction between Writing and Social Studies scores for the laptop cohort (L). Alternate Hypothesis (8): There is an interaction between Writing and Social Studies scores for the laptop cohort (L).

Null Hypothesis (9): There is no interaction between Math and Science scores for the no laptop cohort (NL). Alternate Hypothesis (9): There is an interaction between Math and Science scores for the no laptop cohort (NL).

Null Hypothesis (10): There is no interaction between Math and Science scores for the laptop cohort (L). Alternate Hypothesis (10): There is an interaction between Math and Science scores for the laptop cohort (L).

Null Hypothesis (11): There is no interaction between Science and Social Studies scores for the no laptop cohort (NL). Alternate Hypothesis (11): There is an interaction between Science and Social Studies scores for the no laptop cohort (NL).

Null Hypothesis (12): There is no interaction between Science and Social Studies scores for the laptop cohort (L). Alternate Hypothesis (12): There is an interaction between Science and Social Studies scores for the laptop cohort (L).

Null Hypothesis (13): There is no relationship between OGT subtest scores for content areas, and the at-risk population of students with an economic disadvantage. Alternate Hypothesis (13): A relationship exists between OGT subtest scores for content areas, and the at-risk population of students with an economic disadvantage.

Sampling Procedures

Population

In total, 193 students, including 2014 (109) and 2015 (84) high school 10th graders, make up the sample population. In selecting population participants, a non-probability sampling (purposive sampling) process was used. Trochim (2006) explains that the chief difference between probability and non-probability sampling is the absence of random sampling in non-probability methods. In the case of this study, participants were intentionally selected (purposive) to look only at two grade classes at the high school (2014 tenth graders and 2015 tenth graders). Of the initial sample, participants were further screened to eliminate any 10th grader who might have been enrolled as a 10th grader at the school studied, but attended class somewhere else (i.e., online or alternative county school or special unit). These students were removed from the sample as they did not participate in the laptop program at this school nor did they participate in traditional classes at the school. The purpose of this sampling process was to compare Ohio Graduation Tests scores of only those 10th graders who participated in the 1:1 laptop program at the school (2015) to the OGT scores of the 2014 tenth grades who would have participated in traditional instructional settings in the same high school. Since this is a non-probability sample, the theory of probability cannot be used to justify the use of the sample for generalization purposes (Trochim, 2006).

Using the Ohio Department of Education online Secure Data Center for school administrators, OGT scores for each student by subject area were retrieved. Additional data determining socioeconomic status for the sample population were retrieved from school records and were added to the sample. For ethical purposes in maintaining confidentiality and anonymity, all student names associated with data have been removed, leaving only assigned identification numbers as labels for individual scores. The school's name and any reference to specific teacher names were also omitted. Any sophomore who did not take the Ohio Graduation Test in March of their sophomore year were removed from the sample. This also excludes those students who moved out of the district prior to the March administration of OGT tests and also any junior or senior who would have be doing a retake of one or more subtests. From the initial data set, five (5) students were removed because although they are technically enrolled in this high school, they participate in online classes provided by a third party and would not have participated in either traditional classes or the 1:1 laptop program. Two (2) other students were removed from the sample because they attend school at an alternate facility through the county Education Service Center (ESC).

Participants

The school in this study is located in Columbiana County, Ohio. The total population of the high school for grades 9-12 is 396. Students eligible for a free or reduced lunch and thereby being designated as economically disadvantaged represent forty-seven percent (47%) of the school district population. The average annual income for households in the district is $36,500 and the largest employer within this rural school district is the school system.

Two groups of participants were used in the sample for this study. The first group (IV) is made up of all the high school's 10th graders (109) who took the Ohio Graduation Test in March of 2014. All participants took all five content area subtests. This group had not been given laptops and eTexts to aid in their instruction and learning. Traditional textbooks and teaching practices were used. Of this first group of students, males comprised 42% (46) and females comprise 58% (63). The economically disadvantaged co-variant was at 40% for the 2014 cohort.

The second group of participants (IV) includes all of the high school's tenth graders (84) who took the Ohio Graduation Test in March of 2015. All participants took all five content area subtests. These students were given laptops and began using electronic textbooks at the start of their freshman year, and continued on with these electronic tools through their sophomore year. For their sophomore class teachers, however, this was the first year using the laptops and eTexts. The 2015 group of students included 51% (43) males and 49% (41) females. Those considered economically disadvantaged (ED) make up 35% (29) of the 2015 cohort and 8% (7) of these students have an IEP indicating a learning disability. Just over 2% (2) of this second cohort of students are considered to be in a racial or ethnic minority.

Figure 7 provides a demographic comparison of the 2014 and 2015 tenth grade cohorts.

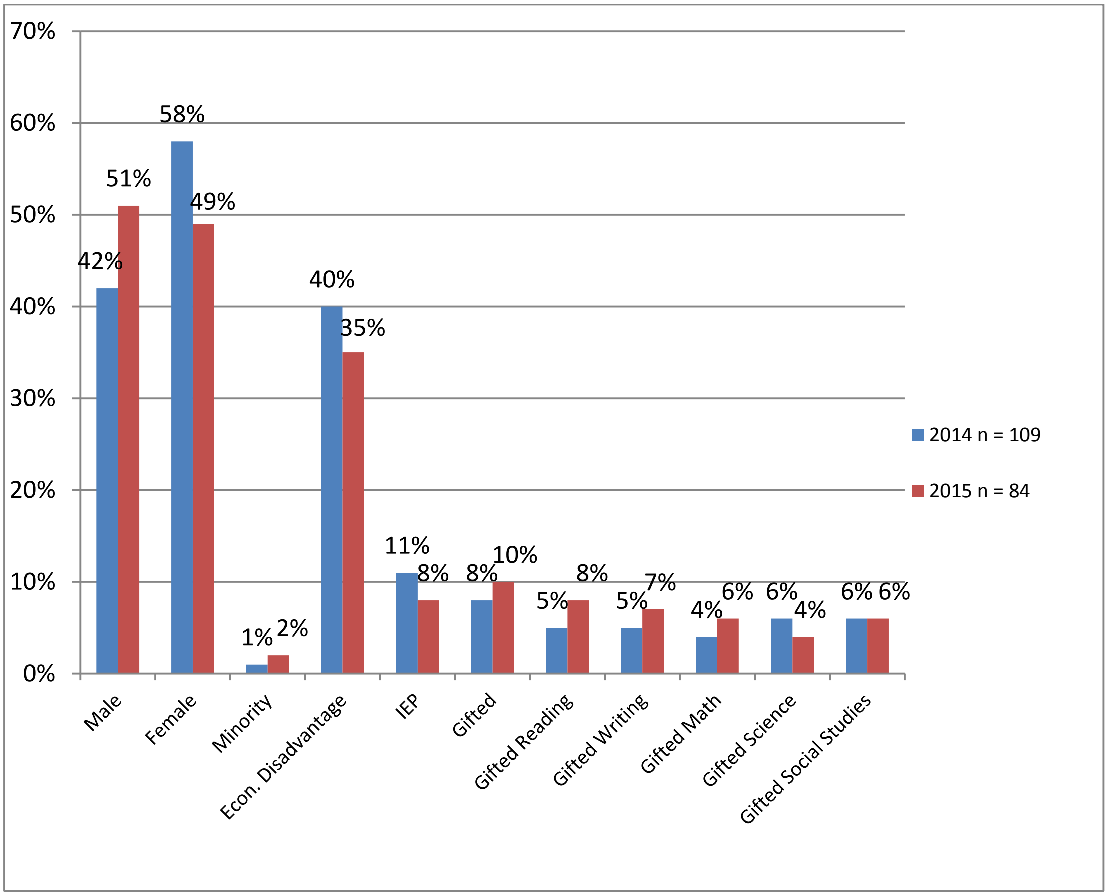

Figure 7. Demographic variable comparisons.

Table 13 provides a glimpse of the spreadsheet containing OGT student scores from the data used in the sample. Two of the 193 data records are shown:

Table 13

Example Data from Sample Population

Assigned Number	Year	Minority Status	Gender	IEP	Economic Disadv.	R_SCOR	W_SCOR	M_SCOR	SS_SCOF	S_SCOR	OGT Total Score
51	1	2	2	1	2	404	398	387	400	399	1988
108	2	2	1	2	1	397	397	393	389	369	1945

Program Implementation

The 1:1 Laptop Program at the School in this Study

"This [technology] has changed my entire approach to teaching," said one of the ninth grade Algebra teachers at the school of focus for this study, (personal communication, November 14, 2014). This teacher had taught at the Ohio high school for six years, but had completed his second year with the school's 1:1 laptop program at the time of this discussion. Students are issued a laptop and online textbooks for English, Math, Science, and Social Studies classes. These devices and applications go well beyond engaging students who are digitally motivated. Students complete homework assignments and take assessments online while interacting with instructors using messaging apps. "Instead of spending hours every night grading papers," the teacher added, "I am responding to help questions on the fly, while assignments are graded instantaneously by the [MathXL] computer program," which accompanies the Pearson electronic textbook. Students work for mastery of concepts using this program, which requires that they keep working problems until they get them. Before, students who did not understand a process would reinforce their errors by doing an entire homework assignment using the wrong process. Now, they have several help options, such as video links or click-on links that review concepts and provide examples. "When they get stuck, they shoot out a question to me using email, and I can reply to them instantly using my phone. I have even answered questions one Saturday from the golf course…" the teacher explained. Instead of wielding through stacks of papers each night, the teacher logs into the program at the start of the school day and pulls up an analysis report for each class that tells him which homework concepts students struggled with the most. This formative assessment feedback provides a data-driven roadmap pointing to where to begin with each class of students (Buzzetto-More, N. & Alade, A., 2006).

This high school is a rural school district in Northeast Ohio. Getting to this point and continuing to build on the initial success and excitement of the 1:1 program involved significant work and preparation. Teachers, like this Math teacher, have been following a traditional model that has been used in teaching students since the birth of a community education approach that we refer to as the school system. The last time schools saw a major overhaul of this magnitude was during the Renaissance period with the invention of the printing press. Nearly 15 years ago, Castells (2001) wrote "The Internet is becoming the essential communication and information medium in our society, and stands alongside electricity and the printing press as one of the greatest innovations of all time" (p. 1). The technology changes taking place today may ultimately have an even greater impact on education than did the ability to print books. We have gone from mass producing copies of information to the mass distribution, collaboration, and interaction with information on an exponential scale.

With all of this potential, there is still a host of reasons why many schools shy away from venturing into the arena of 1:1 teaching and learning: school funding reductions, Wi-Fi infrastructure and capacity limits, students without internet at home, day-to-day laptop maintenance problems, the potential for disruptive behaviors associated with social media, teacher buy-in and community support, to name a few (DuFour, 2007; Keengwe et al., 2011; November, 2013; Silvernail, 2004; Valiente, 2010). For sure, some 1:1 programs have encountered problems like these that are coupled with the reality of expensive efforts failing to yield improved academic achievement (Argueta et al., 2011). Other studies have suggested that positive gains in achievement are being realized when the digital divide is negated and where frequency of use and adequate teacher training are central program components (Mo, D., et al., 2012).

As the researcher embarks on this study, it is important to articulate the program implementation process used at the high school being studied, providing the context for this 1:1 laptop program. The initial planning team began by brainstorming program topics and potential barriers. To help facilitate discussions about unknown concerns, a representative from one of the major textbooks companies (Pearson) was invited to this initial meeting to add pragmatic and logistical input regarding electronic textbooks. The goal of this meeting was to generate as many questions as possible, questions that the team would work through in subsequent meetings prior to board approval of the program and implementation. As the meetings progressed, the team researched and discussed device options, policies and procedures, logistics, electronic textbooks, staff training, program costs and a plan for funding. Figure 8 reflects the decision making process used by the 1:1 Team:

The High School's 1:1 Team

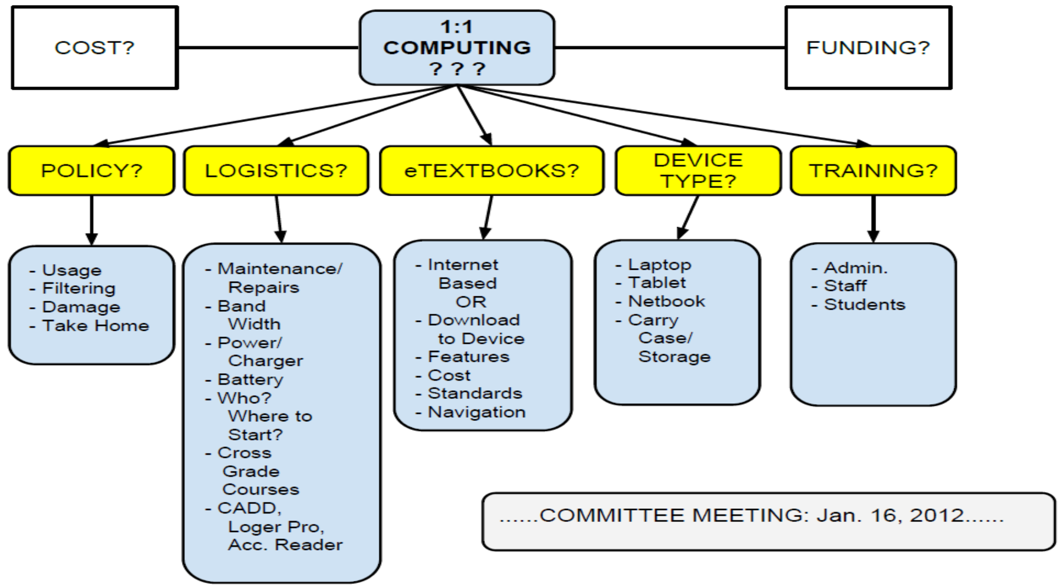

Figure 8. Flowchart of questions raised at initial 1:1 team meeting.

Time and Team

The implementation of any systemic change is everything but an executive decision (Fullan, 2005). At this school, a committee lead by the building principal began working on a plan 18 months ahead of laptop distribution and use. First, the 1:1 Team of staff members was assembled to meet monthly. The team was made up of the building principal, district technology coordinator and district computer technician, and all ninth grade teachers who would be using laptops and e-texts in their classes for the initial year. An invitation to other teachers who shared an interest in developing a 1:1 program was also extended. In total, program research and planning started with a 10 member team. And each year, teachers who would be a part of the program for the following year were added to the 1:1 Team. For example, in the planning year prior to implementation, teachers included on the team were those who teach ninth grade English, Math, Science, and Social Studies. The next year, (2013-14), tenth grade teachers in the same subject areas were added to the team (1 year in advance of the year they would begin using laptops & e-texts). During the 2014-15 school year, 11th grade teachers were included in the 1:1 Team in preparation for the 2015-16 school year. The 2015 OGT test takers who make up the laptop group for this study were the first group of students to be a part of the laptop program at the school. They were ninth graders during the implementation year (2013-14) and took the OGT in March of their 2014-15 school year. The 2014 tenth graders were the last class of students to not participate in the school's 1:1 laptop program. The 2014 tenth graders are now 12th graders and the 1:1 laptop program now includes grades nine through eleven.

Device Decisions

One of the earliest decisions pertained to which device would give to students. While netbooks and tablets are smaller and more portable, their screen size, keyboard, lack of USB access or processor limitations lead the team to go with a standard laptop. The limitations of other types of devices were also problematic as the team looked to the device being a means for facilitating Ohio's new web-based Next Generation Assessments. The school studied worked with a reputable company that refurbishes quality laptops and provides a five year no-drop warranty, (CDI Computer Dealers Inc.). Add on the cost of a carry case and laptops were approximately $500 each (including the 5 year warranty). The team continues to evaluate the device choice annually comparing current laptops to other options, knowing that the device can change as technologies and needs evolve. For the 2015-16 school year, freshman were given a refurbished Dell

Latitude E6420 laptop and a change of carry case was made to begin using laptop backpacks instead of satchel bags.

The school's 1:1 Team began by looking at the ISTE website (International Society for Technology in Education) in researching device options. A more recent posting on the ISTE website lists five questions to ask your team as you consider devices (Krueger, 2014): What do you want to accomplish in the classroom? What can be done with free technology? Is the infrastructure in place to support the device? How long will the device remain relevant? Does it serve teachers and students to have only one device? Ultimately, the team had to agree on which educational limitations they were acceptable and also the budget limitations imposed in determining the device selection.

Electronic Textbooks

Textbook company representatives were brought in to meet with department teachers to showcase their electronic textbook_features and alignment to the state standards. Teachers also received access to the online textbooks and accompanying resources along with a hard-bound copy of each e-text for review. A rubric was used by teachers to compare companies and facilitate the adoption of textbooks by the school board. It is important to note that the team believed that without including the use of interactive electronic textbooks and their companion internet resources, the school would be placing expensive laptops in the hands of students without being able to take advantage of the available technology in each of the subject areas (Shapely et al., 2009). It would be like buying a car with no place to go. Sure, you could sit inside and listen to the radio, but it would be a pretty expensive radio.

> In every case of failure I have observed, the one-to-one computing plan puts enormous focus on the device itself, the enhancement of the network, and training teachers to use the technology. Then, teachers are instructed to go! But go where? That's the critical question that must be addressed first. (November, 2013, pp. 1)

One could expect a minimal if any impact on learning by purchasing only a device, and students would still be carrying around stacks of traditional hardbound textbooks, of which most students were not reading anyway.

Operational Rules

Policies and procedures including agreement forms and repair fees for damages were drafted. This process began by dividing among the team a stack of 1:1 policies currently in place at other schools. These, along with legal advice and input from school board members, helped to form a draft of policy and procedures that would take shape over the next several months before finalization and formal approval by the school board. All school policies and procedures are subject to review and revision annually as unforeseen issues arise. This is certainly true of this 1:1 program, especially since it is a completely new program that is nested in a host of unknowns.

Timeline

A four year implementation roll-out schedule was drafted to begin with each freshman class receiving laptops and e-texts. After four years, saturation will have been achieved with all high school students in grades 9-12 fully integrated in the 1:1 program (see Table 13). One year ahead of the first freshman class to receive laptops, all freshman core subject teachers were added to the 1:1 Team monthly meetings. This was critical, as these teachers would be the first to use the laptops and e-texts with their students. These teachers were also given laptops and access to the online teacher editions they would be using the next year. This allowed these teachers to have a full year to get to know how the devices and e-texts work. As seen in the roll-out schedule, the initial teacher pilot group received netbooks (Table 1: 2012-13). The pilot group experience helped us to know that netbooks were inadequate. By the time our first group of student received devices, the decision to go with laptops had been made. And with each year following, our 1:1 team and its monthly meetings is expanding to include the next grade level of teachers, one year in advance of those teachers using their new e-texts with laptops.

Table 14

Implementation Schedule for 1:1 Roll-out

1:1 Implementation Schedule

	Device	Policy	Logistics	e-Textbooks	Training	Communication	*Other*
Teacher Pilot w/Netbook	Acer Aspire One	Nov. 16 - Initiate	New Wireless Network	Oct. 16 - Pearson/	Aug. 20, 2012	BOE Adopt Policy	
	722-0369	Policy Study		Prentice Hall Intro.	Orientation	Apr. 1, 2013.	
			Evaluate Maintenance	Evaluate Online		MGO Approve Budget	
2012-13	Evaluate Aspire Netbook	BOE Approval	Program	Options			
	Grade 9	Put Policy on	Store 10% of # ordered	Algebra I	Teacher Training for	Student/Parent	
Year 1	Dell Latitude E6400	Website	for students (back-up)	Grade 9 Lang. Arts	eTextbooks	Orientation	
	(Grade 10 teachers	Evaluate Policy	Repairs/Maint. w/CDI	Grade 9 Soc. St.	Aug. 7, 2013	Aug. 22, 2013	
2013-14	Pilot)			(Science 9)	Aug. 19, 2013		
	Grade 9 (new)	Evaluate Policy	Evaluate Maintenance	Geometry	Teacher Training for	Student/Parent	**Online State**
Year 2	Dell Latitude E6400		Program	Grade 9 & 10 Science	eTextbooks	Orientation	**Assessments**
	Grade 10			Grade 10 Lang. Arts		Aug. 21, 2014	**Begin**
2014-15	(Grade 11 teacher Pilot)			Grade 10 Soc. St.			
	Grade 9 (new)	Evaluate Policy	Evaluate Maintenance	Algebra II	Teacher Training for	Student/Parent	
	Dell Latitude E6420		Program	Grade 11 Lang. Arts	eTextbooks	Orientation	
Year 3	Grade 10		(go w/backpack)	Grade 11 Science			
	Grade 11			Grade 11 Soc. St.			
2015-16	(Grade 12 teacher Pilot)						
	Grade 9 (new)	Evaluate Policy	Evaluate Maintenance	Grade 12 Math	Teacher training for	Student/Parent	
	Dell Latitude E6420		Program	Grade 12 Lang. Arts	eTextbooks	Orientation	**Saturation Achieved: All grades 9-12 students Have Laptops**
Year 4	Grade 10			Grade 12 Science			
	Grade 11			Grade 12 Soc. St.			
2016-17	Grade 12						

Infrastructure

The School district IT coordinator developed a plan and budget to overhaul the school internet system and install Wi-Fi access points to accommodate the entire facility and grounds for hundreds of devices and a capacity to grow. The bulk of the network upgrades took place over the summer months, one year before the student laptop program began.

Table 15

Implementation Budget Analysis (from 2014-15 Management, Goals, and Objectives Meeting)

Item	Cost	Funding Source	Amount
Device (Dell Laptop)	$389		
Carry Case	$30	$$ Traditionally Used to purchase	
5 yr. Extended Warranty	$49	Classroom Computers (PI Revenue)	$10,000
est. Total Per Student	$500	$$ Traditionally used to purchase	$75,000
		hardbound textbooks (PI Revenue)	
Total for 106 9th grade Students	$53,000	$$ Technology Student Fee	
Additional 10 devices	$5,000	$ 20 / student X 100 = $2,000	
		$2,000 X 4 grade levels	$8,000
Total Device Cost	**$58,000**	(less 30% free & reduced)	-$2,400
eTextbooks			
yr. 1 (3 sub. @ $80)	$240		
Total	$24,000		
yr. 2 (5 sub. @ $80)	$400		
Total eText cost	**$48,800**		
Total 1:1 w/eText Cost (annual)	**$106,800**	**Total Funding (sources)**	**$90,600**
(based on yr. 2)			
All P.I Money used for devices & eTexts			

Budget Planning

Table 15 illustrates how money was repurposed in the high school budget to build an ongoing annual allowance for funding the laptop and e-text program. Money that had been used for the annual purchase of new hardbound textbooks was directed toward the purchase of new e-textbooks, along with a classroom set of hardbound textbooks to use if and when the internet would go down. Monies that had previously been designated for the annual replacement of computers in classrooms and computer labs are now being used for the purchase of student laptops. Moving toward individual student laptops, the school has been able to reduce its number of computer labs from three to only one. As the program timeline is rolling out laptops out with each ninth grade class of students, they are only purchasing one grade level of laptops at a time. And finally, a $20.00 technology fee was assessed to each student receiving a laptop. Students who are eligible for a free lunch do not pay this fee and those who receive a reduced lunch fee pay a half-price technology fee of $10.00. When all the numbers are crunched, the 1:1 laptop program with e-texts is currently costing our school district $16,200 more than our traditional curriculum program and classroom computer purchases (based on year 2 / 2014-15). Keeping the cost of the program low is vital to the sustainability of the program, especially given the current state of school funding reductions. As Guimarães et al. (2013) reminded us, a program without a built-in sustainability plan is not one that is intended to last.

Communication

Information was regularly provided to the school board as the proposed program developed and is still discussed in detail as part of the district's annual budget planning meetings. Media releases were used to explain the reasons behind the initiative and how it would be funded. Annual surveys are used to gather feedback from teachers, students, and parents. As with any new and significant program, it is important to communicate regularly, inform all stakeholders, and genuinely accept constructive feedback on how the program can be improved going forward (Inan & Lowther, 2010; Jones & Cowie, 2010).

An annual Freshman Laptop Orientation meeting was set to take place with incoming ninth graders and their parents prior to the start of the school year. The team still debates the question of when is the best time to have the orientation, and have so far added a make-up orientation that takes place during the school's open house at the start of the school year.

Professional Development

Solving all of the potential barriers discussed so far, however, will still leave a school wondering why they ever started a 1:1 program, unless genuine time and resources are committed to training teachers (Holcomb, L., 2009). Having the teachers involved in the program participate in our monthly 1:1 Team meetings has helped monitor and troubleshoot needs. Video trainings for e-texts have been available and webinars provided by the textbook companies have been used to assist teachers with e-text programs. The importance of designating and setting aside specific times for these teacher trainings cannot be underestimated (Keengwe et al., 2011). Likewise, training sessions that are specific to content areas (as opposed to training staff together across content areas) was not part of the initial preparations, but has been modified for the 2015-16 school year as it has been proven to better prepare teachers for technology integration (Harris & Sass, 2008; Klieger et al., 2010).

Several years prior to beginning this program, the school moved aggressively toward using *Google Apps for Educators* as a collection of tools for integrating web-based communication and collaboration. For the 2013-14 school year, the entire school district switched over to Google email (Gmail) and beginning with the 2014-15 school year, Gmail accounts with Google Drive accounts were issued for all students. Trainings have been provided for teachers to learn how to use the new Google Classroom, which allows an easy way to issue, collect, organize and grade assignments, post notes, and provide feedback to students. The school chose Google because it is free and it integrates seamlessly across many different apps.

Summary

Silvernail and Gritter (2007), asserted that an innovation such as adopting an 1:1 laptop program can take five to eight years before you can truly know its impact. Similarly, Fullan (2000) suggests that successful change in a secondary school can take six years. The 1:1 laptop and e-text initiative at this small rural school district is relatively new, but it is already showing the potential for making marked improvements in student achievement. Still, the excitement of successes is kept in check by the ongoing day-to-day challenges associated with giving laptops to students. In the 2014-15 school year, the refurbished laptops given to ninth graders had more mechanical problems than did the first year. Roughly 15% of the 2014-15 freshmen had some type of maintenance issue this. For this reason, the decision to go with a higher grade laptop model and laptop backpacks was made.

Instruments

Instruments used in assessing student achievement in the content areas of Reading, Writing, Math, Social Studies, and Science were the Ohio Graduation Tests (OGT's). These standardized tests are administered under the protocols and procedures set forth by the Ohio Department of Education. Tests were administered by the high school staff (serving as trained proctors) to the school's tenth graders. Students were tested each of the two years, all at the same time with the exception of a few make-ups due to absence. All make-up testing occurred within a two-week window of the regularly designated time. Regular testing of students occurred in class size groups of approximately 24, with the exception of special education students with an IEP (individual education plan) requiring alternate accommodations. All tests were collected, scored, and scaled by the state of Ohio as a way of comparing students for achievement categories (limited, basic, proficient, accelerated, and advanced) and in contributing to the rating of individual schools on annual report cards.

Two cycles of testing were considered for this study. The first tests were given to 2014 tenth graders. These students were administered the Ohio Graduation Tests during the week of March 10-14, 2014. The second testing cycle involved the 2015 tenth graders. These students took the OGT's during the week of March 16-20, 2015.

List of Variables

The following is a list of variables and how they were coded for the purposes of this study:

- Independent Variables
    - Treatment (1 = no laptop program/2014; 2 = laptop program / 2015)

- Dependent Variables
  - Total Score (combined OGT subtest scores for each student)
  - Writing Subtest Score (W_SCOR)
  - Reading Subtest Score (R_SCOR)
  - Math Subtest Score (M_SCOR)
  - Science Subtest Score (S_SCOR)
  - Social Studies Subtest Score (SS_SCOR)
- Covariate
  - Economic Disadvantage (1 = ED; 2 = No ED)

Data Analysis

After converting subtest scaled scores to Z scores and calculating Total OGT Scores, a <u>one-tailed T-Test</u> for independent means is used for statistical analysis in examining these scores for individuals in the two groups (Research Hypothesis 1). This statistical test was chosen because the comparison is between two specifically different groups (2014 tenth graders and 2015 tenth graders) and is considering one variable (total or combined OGT subtest scores). This inferential treatment is appropriate for this hypothesis because it determines the statistical difference between the means of two groups (Trochim & Donnelly, 2006).

A one way <u>MANOVA</u> (multiple analysis of variance) makes the achievement comparison for each of the five subtests: Reading, Writing, Math, Science, and Social Studies when looking at the 2014 and 2015 cohorts (Research Hypothesis 2). This statistical test was chosen to investigate the difference between 2014 and 2015 scores among the dependent variables. This treatment is appropriate for this hypothesis because it evaluates independent groups while looking at a continuous dependent variable to determine if there are any differences between the independent groups (Lund & Lund, 2013).

A two-way MANOVA (multiple analysis of variance) is used to determine the differences between the 2014 and 2015 groups in association with the 1:1 laptop program among OGT subtest scores when considering the covariate of economic disadvantage (Research Hypothesis #3).

Summary

This study seeks to understand the relationship between one rural high school's 1:1 laptop program and student achievement as measured by the Ohio Graduation Test (OGT). It will not establish a cause and effect. The sample population includes 2014 tenth graders who experienced traditional instruction in their core subject courses (English Language Arts, Algebra 1 or Geometry, Biology, and American History) which correspond to the five subtests of the OGT (Reading, Writing, Math, Science, and Social Studies). The scores from this first group are compared to the scores of a second group which includes 2015 tenth graders participating in the 1:1 laptop program (treatment). A quasi-experimental ex post facto design is used to compare the two groups (independent variable).

The statistical analysis of student scores herein aims to compare (1) overall OGT scores (total of all five subtests), (2) individual subtest scores, and (3) demographic variance based on economic disadvantage.

Limitations

Although the data from this sample are relatively comprehensive to the setting (10th graders at the high school studied), there are a number of limitations that must be acknowledged. As discussed earlier, sampling is not random in the ex post facto design, making it difficult to suggest that the findings are representative of the larger population (at this high school and beyond). This study is further limited by lack of controls for related factors. As the literature review suggests, these factors might include the implementation procedures used for the 1:1 laptop program, teaching practices (pedagogical), and frequency of laptop use. Third, as Canuel, (2010) asserted, the use of standardized tests (such as the OGT) does not measure the very twenty-first century skills that are facilitated most naturally with laptop programs. And finally, this study is limited by the scope of time. Participants in the treatment group (laptop program) had access to laptops and electronic textbooks for only two years (9th and 10t grade). And for the teachers who taught them during their 10th grade OGT year (2015), this was their first year using the laptops and eTexts. Without a longitudinal perspective, we cannot consider trends or a potential implementation dip (Fullan, 2001). Once the program takes hold, improved achievement gains could be expected. While this study is limited and certainly does not allow us to establish cause and effect regarding the laptop program, it does provide an opportunity to explore the phenomena of the relationship between the program and student achievement, providing a baseline for further study and ongoing evaluation.

CHAPTER IV

FINDINGS

Introduction

Education is undergoing a significant pedagogical transformation, rapidly changing in an attempt to remain relevant amidst technologies that appear to evolve more rapidly with each passing day. One vehicle purported to advance educational aims that is growing in popularity is the 1:1 laptop program, whereby each student and each teacher is given a personal laptop to use at school and at home (Fleischer, 2012). In addition to individual devices, many programs are also transitioning to the use of web-based interactive electronic textbooks (Duncan et al., 2014). With a cacophony of program models and mixed results, 1:1 programs might best be summed up as a massive systemic experiment, ripe for analysis and hungering for evaluation.

The purpose of this research is to add to the discussion a study of the relationships between a 1:1 laptop program in one rural Ohio high school and state test results on the Ohio Graduation Tests. Employing a quasi-experimental ex post facto design, the researcher compares the achievement test scores of two different year cohorts in the same high school, one taking the 10th grade OGT following traditional instruction in their ninth and tenth grade years (without laptops and eTexts) and the second group taking the 10th grade OGT following instruction given with laptops and eTexts during their ninth and tenth grade years. Sophomores testing in 2014 were the no laptop cohort and sophomores in 2015 were the laptop cohort. The laptop cohort of students was given laptops and eTexts to use beginning with their ninth-grade year and as such received instruction with laptops for two years prior to taking the OGT. At the 10th-grade OGT test year for this laptop cohort, however, 2015 was the first year the 10th-grade teachers would be instructing with the use laptops and eTexts. This was due to a phased in model by grade level.

With the current school year (2016-17), the laptop cohort are now seniors and with the completion of the phased-in model, all 9-12 grades have laptops and eTexts. The no laptop cohort took the OGT in 2014 but graduated in 2016 and was the last grade level to receive traditional instruction void of personal laptops and eTexts. For the purpose of this study, scores are compared among these two cohorts (2014 no laptop 10th graders and 2015 laptop 10th graders) for OGT tests in the content areas of Reading, Writing, Math, Science, and Social Studies. The results of the analyses are presented in this chapter.

Looking at the relationship between the 1:1 laptop program and OGT tests, we consider three research questions to direct our analyses. First, the question of relationship between the laptop program and the OGT passing rates (score of 400 or greater) across each of the five subject area scores is explored. A Chi-Square test is used to examine the passage rates for question #1. Additionally, an examination of corresponding OAA scores from both OGT cohorts' eighth grade assessments was conducted to determine if the two cohorts were already performing differently on state achievements tests prior to the implementation of the laptop program. An independent samples *t*-test was used and determined that indeed, a significant difference did exist between the performance of the two cohorts prior to entering high school and the treatment group (2015 cohort) experiencing the laptop program. Knowing this, OAA scores would be used as a covariate, controlling for the identified pre-existing difference.

Secondly, comparing students' raw scores for each OGT subtest with the addition of the OAA covariate, a MANCOVA was initially used to answer research question two, including OAA scores for the two cohorts as a covariate to account for the existence of the pre-existing significant difference between cohorts. The intent in using the MANCOVA was to understand the laptop program in relationship to the five specific content area subtest scores. As we will discuss shortly, our attempt to employ a MANCOVA was abandoned when assumptions of normality were violated. A Chi-Square Test for Independence was then determined to be the best tool for analyzing categorical subtest scores for movement of the population within the five achievement level categories (Advanced, Accelerated, Proficient, Basic, and Limited).

And finally, question three considers how the laptop program relationship with achievement is framed when looking at the at-risk subgroup of economically disadvantaged (ED) students, again comparing the two cohorts. As with question two, a Chi-Square test for independence of categories has replaced the MANCOVA, which had replaced the originally intended MANOVA, as a means to comparing the performance categories of the ED subgroups for the Laptop and No Laptop cohorts. Again, these scores are analyzed for change of frequency within the Advanced, Accelerated, Proficient, Basic, and Limited performance categories. And similar to question two, the change to a categorical performance level comparison of scores is used (Chi-Square), as opposed to the direct comparison of raw scores, since the violation of normality is significant with regards to the distribution of data. Descriptive statistics for the sample (N=193) are provided in Table 16.

Table16

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Skewness Std. Error	Kurtosis Statistic	Kurtosis Std. Error
OGT_Score	193	1869.00	2442.00	2146.8187	100.52427	-.069	.175	.305	.348
Writing_Score	193	372.00	461.00	424.5440	17.50474	-494	.175	-.372	.348
Reading_Score	193	364.00	475.00	427.9845	17.54591	-.215	.175	.588	.348
Math_Score	193	362.00	556.00	437.1658	31.26389	.884	.175	2.573	.348
SS_Score	193	363.00	507.00	430.4041	24.64672	-.013	.175	.527	.348
Science_Score	193	350.00	501.00	426.7202	25.33349	-.110	.175	.360	.348
SMEAN(OAA_Read)	193	364.00	538.00	436.0275	26.58877	.442	.175	1.117	.348
SMEAN(OAA_Math)	193	365.00	494.00	425.4066	22.24976	.058	.175	-.049	.348
SMEAN(OAA_Science)	193	360.00	497.00	424.9890	24.57959	-.086	.175	.306	.348
SMEAN(OAA_Total)	193	1129.00	1437.00	1286.4231	65.54246	.023	.175	-.301	.348
Valid N (listwise)	193								

Pre-Analysis Data Screening

Screening data for accuracy, missing data, outliers, and normality are standard procedures that are prerequisite to performing any formal analysis (Mertler & Vannatta, 2005). To be sure that the data used for this study accurately reflects a comparison of students who physically attended and participated in the curriculum and instruction provided at this high school and who took the OGT test during their 10th-grade year, an initial review of student/case numbers was conducted. From the initial data set, five (5) students were removed because although they were technically enrolled in the high school studied, they participated in online classes provided by a third party and would have participated in either traditional classes or the school's 1:1 laptop program. Two (2) other student scores were removed from the sample because they attended school at an alternate facility through the county Education Service Center. Following this initial screening for accuracy, 193 cases (*N* = 193) remained between the two cohorts. For the laptop cohort, *n* = 84 and for the no laptop cohort, *n* = 109.

Missing Data

While there were no missing data for the OGT test scores, OAA scores from the eighth grade year (used to compare cohort achievement on previous tests prior to the 1:1 program) did have some missing data for students who later joined the 2014 or 2015 OGT cohorts, but were not students at the school when they were in eighth grade. For the 11 cases of missing OAA scores, the missing data were replaced with the mean scores of the OAA participants for the respective subject area tests in their cohort as reflected in Table 16. Mertler and Vannatta (2005) recommended using the mean to replace missing values when conducting a comparison analysis and when true values cannot be obtained. Using the mean scores shown in Table 17 allows all cases involving OGT scores to be included for comparison without having a significant impact on the results, even when corresponding OAA scores are not available.

Table 17

OAA Mean Scores Used to Replace Missing Data

Variable	Cohort	N	Mean	Std. Deviation	Std. Error Mean
OAA Reading	No Laptop	103	429.17	24.79	2.44
	Laptop	79	444.97	28.17	3.17
OAA Math	No Laptop	103	422.10	21.88	2.16
	Laptop	79	429.72	23.65	2.66
OAA Science	No Laptop	103	421.48	24.80	2.44
	Laptop	79	429.57	25.40	2.86

Rationale for OAA Scores as Covariates

Considering mean scores for each of the three-subject area OAA tests reported in Table 16, we see that there is a difference in the mean scores of the two cohorts. Is that difference, however, significant? In determining a rationale for using the eighth grade OAA scores as covariates in comparing OGT scores in relationship to the laptop program, three procedures were conducted in evaluating the significance of difference between the laptop and no laptop cohorts for their respective OAA tests (Reading, Math, & Science). First, an independent samples *t*-test looked at all data (including cases with missing data). For all three subject area tests, a significant difference between OAA cohort scores was determined, with the laptop cohort already outperforming the no laptop cohort on these eighth grade state assessments (OAA Reading $t\,(180) = -4.02$, $p < .001$, OAA Math $t\,(180) = -2.25$, p=.026, OAA Science $t\,(180) = -2.16$, p=.032). A second *t*-test examined the same comparison of OAA scores, but this time replacing missing data with the means illustrated in Table 16. Similarly, the difference between cohorts on all three subtests was still significant (OAA Reading $t\,(191) = -4.27$, $p < .001$, OAA Math $t\,(191) = -2.39$, p=.018, OAA Science $t\,(191) = -2.31$, p=.022). A final *t*-test was conducted after removal of outliers in the data that may have been skewing that data. With all three subject area tests, a significant difference between the cohort OAA scores remained, even with the elimination of outliers (OAA Reading $t\,(181) = -5.32$, $p < .001$, OAA Math $t\,(190) = -2.67$, p=.008, OAA Science $t\,(186) = -2.134$, p=.02). These analyses tell us that prior to the laptop program, there was already a significant difference between the state test performance of the two cohorts on the eighth grade OAA. Knowing this, the use of the OAA scores as a covariate in comparing the OGT scores of these two cohorts is justified, as in doing so will help to account for differences in performance that already existed between cohorts prior to the initiation of the 1:1 laptop program. Since all three analyses yield similar results, that data with missing scores replaced with mean values was used, providing the most complete set of data for evaluation.

Outliers (OGT Test Scores)

As with the OAA scores, the OGT data set was evaluated for potential outliers. Extreme values in a data set distort statistical results of which typically use some version of the mean for analysis (Mertler & Vannata, 2005). Using SPSS, outliers were identified for the extreme scores identified. For these extreme values, scores were replaced with the mean value for their respective subject area test. Looking for outliers among the OGT scores for the 193 cases, four outliers were identified as illustrated in Table 18.

Table 18

Outliers/Extreme Values

Test Area	Cohort	Case #	Value	Replaced w/ Mean Value
OGT Reading	No Laptop	7	364	428
OGT Math	No Laptop	36	556	437
OGT Math	Laptop	160	552	437
OGT Math	Laptop	175	552	437

No outliers were identified for OGT Writing, Science, or Social Studies scores. Table 19 reflects the mean score values determined for each variable considered:

Table 19

Mean Scores for Dependent Variables

Variable	N	Mean	Std. Deviation
Reading OGT	193	427.98	17.55
Writing OGT	193	424.54	17.51
Math OGT	193	437.17	31.26
Science OGT	193	426.72	25.33
Soc. Studies OGT	193	430.40	24.65

Normality: A Problem and Solution

The data were examined in considering three general assumptions required of multivariate statistical testing: normality, linearity, and homoscedasticity. At this juncture, our analysis confronted a significant violation of the assumption of normality required for the MANCOVA. With population scores being too high, we were unable to find alpha levels > .05 on the Kolmogorov-Smirnov test of normality. For scores in the subtests of Reading, Math, and Science, the problem of normality was significant across variables. Scores were not normally distributed. Due to the nature of the data (scaled scores that were significantly skewed negatively as a result of overall high scores), an attempt at transforming the data was discarded as the meaning of the data and population would change greatly.

At this point, and as alluded to in the introduction of this chapter, our analysis would follow a different course going forward. As opposed to looking at the sum of individual scores for our first research question, the Chi-Square test would be used to compare the overall passage rates of the two cohorts across all five subtests. Being unable to conform to the statistical assumptions for a MANCOVA to compare individual student scores among cohorts for questions two and three, the best alternate course of analyses was determined to be comparisons of how those scores moved/changed in each cohort within performance categories: Advanced, Accelerated, Proficient, Basic, and Limited. Considering the nature of the research, being applied as opposed to basic, this approach was chosen as the most valid method for answering research questions two and three. Research questions two and three, which compare the performance of the two cohorts within the subtests of Reading, Writing, Math, Science and Social Studies, remain the same. What changed, however, was the methodology; the statistical vehicle used to answer those questions. Instead of using a MANOVA or a MANCOVA for the reasons explained, Pearson's Chi-Square Test of Independence was employed. Table 20 reflects the originally intended statistical methodology used for all three research questions (discussed in Chapter 3) in comparison to the new path for data analysis determined as a result of the data constraints described in this chapter.

Table 20

Outline of Modified Methodology Based on Data Constraints

Research Question	**Intended Design**	**Intended Method**	**Modified Design**	**Modified Method**
1. Do participants in the laptop program (2015 10th graders) score higher than non-participants (2014 10th grades) on the OGT?	Compare the overall achievement scores (across all five subtests) of the two cohorts.	One-Tailed *t*-test for independent means	Compare overall OGT passage rates (percentage of student scores placing in the "proficient" or higher category, scoring at least 400).	Chi-Square test (comparing expected performance to observed performance).
2. Does participation in the 1:1 laptop program (IV) significantly affect OGT Reading, Writing, Math, Science, or Social Studies achievement scores, among 10th grade students?	Compare the scores of the two cohorts for each of the five OGT subtests.	MANOVA (then tried) MANCOVA	For each subject area OGT subtest, compare the expected numbers of scores to fall in each performance category (Advanced, Accelerated, Proficient, Basic, Limited) to the actual counts of scores in those categories.	Chi-Square test (comparing expected performance to observed performance).

3. Does participation in the 1:1 laptop program affect OGT scores in Reading, Writing, Math, Science, or Social Studies achievement among 10th grade economically disadvantaged students?	Compare the scores of the ED scores of the laptop cohort to ED scores of the no laptop cohort and also to all students in the laptop cohort.	MANCOVA	For the economically disadvantaged subgroup (ED), compare the expected numbers of scores to fall in each performance category (Advanced, Accelerated, Proficient, Basic, Limited) to the actual counts of scores in those categories, considering each of the five OGT subtests.	Chi-Square test of Independence (comparing expected performance to observed performance) .

Summary of Findings

Research Question #1

Do participants in the laptop program (10th grade students in 2015) outperform non-participants (10th grade students in 2014) on the OGT? This first question employs a comparison of overall passage rates for the two cohorts, whereby passing/proficient is based on achieving a minimal scaled score of 400. Passage rates were evaluated for each of the five subject area subtests (Reading, Writing, Math, Science, and Social Studies) with the passing score of 400 being consistent across all five subtests. A Chi-Square test was used to evaluate passage rates in relation to the laptop cohort as compared to the no laptop cohort in determining significance of difference. This is an appropriate test as it compares the pass/fail rates between the two groups on the same dichotomous, dependent variable. In short, it answers the first research question which asks if the overall performance of the two groups is statistically different (Mertler & Vannata, 2005)? For the independent variable (laptop cohort/no laptop cohort), all scores were measured at the nominal level (categorical). For the no laptop group, 79% of the students passed all five parts of the OGT. In comparison, the laptop cohort saw a passage rate of 83.1%. Although the passage rate was higher for the laptop cohort, the difference is not significant (χ^2 (1, N = 189) = .46, p = .50). Overall passage rates for the two cohorts were similar.

Research Question #2

While the percentage of students passing all five OGT subtests is not significantly different in comparing the laptop and no laptop cohorts, our second research question asks if participation in the 1:1 laptop program (IV) significantly affects the individual subtests of OGT Reading, Writing, Math, Science, and Social Studies student achievement scores among 10th grade students, after accounting for the predetermined difference in achievement on the eighth grade Reading, Math, and Science OAA assessments? Due to the violation of normality previously discussed with the MANCOVA, a categorical comparison employing Pearson's Chi-Square Test of Independence was used. This analysis determines the difference between cohorts considering the frequencies for which student scores fall within the categories of Advanced, Accelerated, Proficient, Basic, and Limited. Effect size was determined using Cramer's V. As a result of the Pearson Chi-Square analysis, the subtest content area of Math shows that there were significantly more Laptop cohort student scores falling in the Advanced category for the OGT test than is expected for students in that cohort and when compared with the no laptop cohort (χ^2 (4, N = 193) = 11.10, p = .025, Cramer's V = .24). The analysis with Reading performance proved similar, with more student scores falling in the Accelerated category than expected and fewer scores falling in the proficient category than expected in the laptop cohort (χ^2 (4, N = 193) = 9.30, p = .054, Cramer's V = .22). Tables 21 and 22 show the distribution of scores for the laptop cohort within categories for Math and Reading.

Table 21

Math OGT Scores in Achievement Categories for the Laptop Cohort (n=84)

Achievement Category	Actual *n*	Expected *n*	Residual
Advanced (highest)	44	33.5	10.5
Accelerated	17	22.6	-5.6
Proficient	19	20.9	-1.9
Basic	2	4.4	-2.4
Limited (lowest)	2	2.6	-0.6
Total	84		

χ^2 (4, N = 193) = 11.10, p = .025, Cramer's V = .24

Table 22

Reading OGT Scores in Achievement Categories for the Laptop Cohort (n=84)

Achievement Category	Actual *n*	Expected *n*	Residual
Advanced (highest)	13	11.8	1.2
Accelerated	36	27.9	8.1
Proficient	33	40.0	-7
Basic	2	3.5	-1.5
Limited (lowest)	0	0.9	-0.9
Total	84		

χ^2 (4, N = 193) = 9.30, p = .054, Cramer's V = .22

The analyses for Writing, Science, and Social Studies indicated no significant difference in performance across categories respectively: Writing (χ^2 (3, N = 193) = 2.62, p = .455); Science (χ^2 (4, N = 193) = 1.67, p = .793); Social Studies (χ^2 (4, N = 193) = .76, p = .943).

Research Question #3

Does participation in the 1:1 laptop program affect OGT scores in Reading, Writing, Math, Science, and Social Studies among 10th grade economically disadvantaged students (ED)? For the reasons explained previously regarding violations of the normality assumption for MANCOVA, question three also employs the Pearson's Chi Square statistical analysis in answering question three. As such, we look at the number of ED student scores that are expected to fall within each of the performance categories, (Advanced, Accelerated, Proficient, Basic, and Limited), for each subject area test and compare the actual count to their corresponding expected numbers. Specifically, we want to know if any significant differences in expectations occurred for the ED subgroup in the laptop cohort. As reflected in the Pearson Chi-Square analysis, there were no significant differences from what was expected in the no laptop cohort in any of the five performance level categories on any of the content area subtests. In comparison, the analysis for the subtest content area of Reading did show a trend, where more ED student scores fell in the Accelerated performance category (n=9) than were expected (n=6) for the laptop cohort ($\chi 2$ (4, n = 29) = 8.194, p = .085, Cramer's V = .335). Being statistically insignificant, however, the finding for the laptop ED Reading subtest scores is impacted by the reality of a small sample (n=29). Still, considering that the change between what was expected categorically and what actually occurred includes 10% of this sample, the significance of the laptop impact on ED reading scores may be greater for ED students than what can be statistically verified. Having a p value greater than .05 (p=.085), we can only say with confidence that ED scores show a trend toward positive movement among performance categories for Reading. The distribution of Reading scores for the ED subgroup of the laptop cohort is provided in Table 23.

Table 23

Reading OGT Scores in Achievement Categories for the ED Subgroup of the Laptop Cohort (n=29)

Achievement Category	Actual *n*	Expected *n*	Residual
Advanced (highest)	3	2	1
Accelerated	9	6	3
Proficient	17	18.3	-1.3
Basic	0	2	-2
Limited (lowest)	0	0.8	-0.8

$\chi 2$ (4, n = 29) = 8.194, p = .085, Cramer's V = .335

For this same subgroup sample (laptop ED students), a positive movement of Math scores proved more impressive with a statistical difference in what was expected in both the Basic and Advanced performance categories for the laptop cohort ($\chi 2$ (4, n = 29) = 9.751, p = .045, Cramer's V = .365). There were fewer laptop ED scores falling in the Basic category (0%) than expected (11%) and more students falling in the Advanced category (31%) than were expected (19%). A problem still exists with the small sample size (n=29), requiring caution when reporting these results as significant. However, if no more than 20% of actual counts are less than 5 and all individual expected counts are 1 or greater, the significance of the findings can stand (Yates, Moore, & McCabe, 1999). These exceptions for accepting findings of significance when the sample size is small hold true with the data analysis presented herein for question three. The difference is significant, showing a positive movement of scores from the lower achievement categories to the highest achievement category. The distribution of Math scores for the ED subgroup of the laptop cohort is provided in Table 24.

Table 24

Math OGT Scores in Achievement Categories for the ED Subgroup of the Laptop Cohort (n=29)

Achievement Category	Actual *n*	Expected *n*	Residual
Advanced (highest)	9	5.6	3.4
Accelerated	9	9.1	-0.1
Proficient	10	9.1	0.9
Basic	0	3.2	-3.2
Limited (lowest)	1	2	-1

$\chi 2$ (4, n = 29) = 9.751, p = .045, Cramer's V = .365

As with question two, there were no significant differences in expectations within performance categories for the subtests of Writing, Science, and Social Studies when considering the laptop cohort.

Summarizing the results of the data analysis as it applies to our research questions, three statements emerge from the findings. First, overall passage rates for the two cohorts (laptop and no laptop) are statistically similar. Secondly, while there is not a significant difference in expectations in performance categories for the laptop cohort in the subtests of Writing, Science, and Social Studies, there is a trend toward a significant positive movement in Reading scores within performance categories and there is a verifiable significant movement of scores to the highest performance category for the subtest of Math. Finally, similar to the results as they apply to subtest categorical performance for all students in the laptop cohort, the subsample of economically disadvantaged students within the laptop cohort perform as expected for Writing, Science, and Social Studies, but trend toward significant improvement for Reading scores while showing significant improvement in performance for Math Scores.

CHAPTER V

DISCUSSION OF FINDINGS

Introduction

Technology and its use in education is ever expanding at a rate that has made it difficult for schools, teachers, policy-makers, and taxpayers to evaluate its impact. Both advocates and detractors have made arguments for and against the question of program cost-effectiveness. With a significant amount of research on the topic of 1:1 laptop programs, we are still left with conflicting results and answers that fall well short of being definitive. Arguably, decades of research have yielded little progress (Fleischer, 2012). And as November (2013) added, a better understanding of the relationship between technology and the strategies that yield improvement in student achievement is critical. Otherwise, we could very well be wasting a lot of time and money. Adding to this discussion, this study set out to identify relationships that potentially exist between a 1:1 laptop program in one rural Ohio high school and the achievement scores of its students taking the Ohio Graduation Tests in the spring of their 10th grade year. Two cohorts of student scores were compared. The cohort of 10th grade students who took the OGT in 2014 received traditional instruction leading up to the tests. The cohort of 10th grade students taking the OGT in 2015 took the same courses with the same teachers, but were the first grade level of students to be given laptops and electronic textbooks as part of a phased in model.

Considering the OGT scores of these two cohorts, the researcher first hypothesized that overall, passage rates of OGT scores would be significantly higher for the laptop cohort (2015) when comparing to the OGT scores in the no laptop cohort

(2014). A second hypothesis suggested that there is this relationship between students with laptops that exist among individual subtest scores for each content area, and that based on current research, this relationship will be most significant for the subtest scores of Writing, with Reading and Math expected to also show lesser gains respectively (Bebell & Kay, 2010; Gulek & Demirtas, 2005; Lowther et al., 2003; Mouza, 2008; Suhr, Hernandez, Grimes, & Warschauer, 2010; Sun, Yang, & He, 2014; Warschauer, 2007). And finally, this study set out to identify a relationship between the hypothesized improved scores for economically disadvantaged students in the laptop cohort when compared to the economically disadvantaged students in the no laptop cohort.

Three specific research questions were asked at the onset of this study in attempt to identify the relationships hypothesized. Findings were presented in chapter four. The narrative in this chapter discusses the findings for each of these questions.

Discussion

Research Question #1

Do participants in the laptop program outperform non-participants on the OGT? This first question employs a comparison the two cohorts (IV) using the overall passage rates for the percentage of students passing all five-subject area OGT tests. This comparison is somewhat unique among the current research, as most studies evaluating student achievement test scores look only at comparisons of specific subject area tests. This is in part due the fact that not every state tests all five core content areas (Reading, Writing, Math Science, and Social Studies). As part of the No Child Left Behind Act national mandate, however, every state does test for Math and Reading achievement (Klein & Camera, 2015). A similar comparison could be made to overall grade point averages, as several studies have evaluated GPA in relation to laptop programs. In these instances, a marginally significant increase in GPAs is reported when students are given laptops (Corn et al., 2012; Gulek & Demirtas, 2005; Holcomb, 2009; Lei & Zhao, 2008). We are also reminded that in any case, simply giving laptops to students without attention how they are being used is fruitless (Freimana et al., 2010). As discussed in chapter two, implementation models as well as outcomes vary greatly among programs that have been studied.

No current research has been found specific to 1:1 programs and achievement test scores in the state of Ohio. In this study, the results of the first research question pertain to the percentage of students who passed all five subject area OGT tests (achieving a score of 400 or higher). The results of this comparison of composite passage rates sheds a broader light on what might or might not be happening in relation to the 1:1 laptop program and suggest that overall, achievement test scores are statistically unaffected by the laptop program. Although the overall passage rate was higher for the laptop cohort (83% compared to 79%), this difference is not significant. Overall passage rates for the two cohorts were similar. In essence, the difference in performance was improved for the laptop cohort, but the improvement was not significant. In context, however, we are reminded that this comparison evaluates the first cohort in the new program to have laptops, being the inaugural laptop cohort graduating class. It is this same group of students whose teachers were using electronic textbook resources for the first time. With a major systemic change such as a transition to laptops and eTexts, research tells us that the first year does not usually yield significantly positive results. In fact, as Fullan (2001) and Mouza (2008) wrote, we should expect an “implementation dip,” where student performance would actually show an initial decline with improvement to follow in subsequent years. Considering what should have been a first year drop in scores, the positive gains reported for question one, although insignificant, could arguably show more of an impact than is indicated statistically. Additionally, it is possible that the implementation dip did occur, but was not evident because the student achievement scores as measured by the prior eighth grade OAA were already higher for the laptop cohort. Two cohorts were not equivalent.

The comparison of overall passage rates for question one, however, does not account for the potential gains made with individual subject area tests. Looking only at students who passed all five OGT subtests, any potential gains among specific subject area tests could be offset by the potential losses in other subject area tests. And similarly, any gains within subpopulations of the sample are not recognized since this initial question considered the population as a whole. To better understand these relationships, additional questions were asked.

Research Question #2

Does participation in the 1:1 laptop program (IV) significantly affect OGT Reading, Writing, Math, Science, or Social Studies student achievement scores among 10th grade students and how might any effect be mitigated by further taking into account the corresponding eighth grade Reading, Math, and Science prior Ohio Achievement Test (OAA) scores for the same students in the two cohorts? While the findings of analysis in chapter four suggests that there was not a significant movement of scores within performance categories for the subtests of Writing, Science, and Social Studies, a notable and significant difference from what is expected for how scores fall within the performance level categories is identified for the subtests of Math and Reading. There were significantly more Math scores falling in the highest achievement category of Advanced. And for the Reading subtest, there were significantly more scores falling in the Accelerated achievement category and fewer falling in the Proficient category than expected. In essence, the laptop cohort saw a significant positive movement of Math and Reading scores within performance categories. Perhaps most striking is that for both Reading and Math, over 50% of the scores for students were in the Accelerated and Advanced performance categories for the Laptop cohort. This positively skewed distribution of scores echoes and points to the violation of normal distribution required for the MANCOVA, which resulted in the use of a Chi-Square test in its place.

We cannot say, however, that our findings for the significant improvement in Math and Reading Scores are an indication of a cause and effect relationship since we know that the laptop cohort already outperforms the no laptop cohort based on our analysis of prior state OAA tests. Though we must exercise caution in our interpretation of these results, we can say with confidence. however, that the laptop cohort is performing at a significantly higher level within its own cohort than what is expected. The Chi-Square results show that counter to what we would expect, there are more student scores in the lower categories (Basic and Limited) for the no laptop cohort and more student scores in the upper categories (Advanced and Accelerated) for the laptop cohort. And finally, while these differences in expectations are significant, the calculated effect size based on Cramer's V (.24) is small. In terms of practical application, however, these differences arguably remain significant. Again in theory, an implementation dip may actually be greater than observed (Fullan, 2001; Mouza, 2008), but is non-apparent due to the positive impact associated with the laptop program. Tables 1 - 6 in Chapter 3 illustrate the variances across performance categories for each of the five OAA and OGT subtests in comparing the laptop and no laptop cohorts for the subtests of Reading, Math, and Science.

As we ponder the significant upward shift of student scores in the laptop cohort for the subtests of Math and Reading, the logical question to follow is twofold: First, why did this occur. Conversely, why did we not see similarly significant gains with Writing, Science, and Social Studies scores? Herein lies the discussion for our findings relative to research question two.

As discussed in chapter two, the nature of electronic textbook resources provides for interactive and engaging learning that is more individualized with instant feedback for students and real-time formative data for teachers. Links to supporting videos and other resources are also available (Kim, 2015). The use of these teaching and learning tools was most notably observed as used by the Math teachers instructing students in the laptop cohort. This is perhaps why that laptop cohort saw Math scores significantly shifting into the highest performance category (Advanced). Reading scores also showed a significant movement from the Proficient category to the Accelerated category. Along with the interactive nature of the electronic resources, additional contextual factors identified in chapter two help to explain the unexpected gains made with both the Math and Reading OGT scores.

Instructional Practices

Instructional practices, wrote Beebell and O'Dwyer (2010), vary greatly and have a genuine influence on the successes and failures of laptop programs. At this juncture, we are reminded that technology will only magnify the instructional methods that are already in place unless real change in pedagogical practices simultaneously takes place in the classroom (Twinning et al., 2014). In attempt to explain the outcomes of this study, particular to the absence of gains in the laptop cohort for the subtests of Writing, Science, and Social Studies, we are reminded that no single factor impacts the success of a laptop program more than the teacher (Lowther, 2010). And by extension, the instructional practices employed in the classroom are one of the most significant factors impacting outcomes (Gaudreau et al., 2014). More so than any other subject area examined in this study, Math classes, with students in the laptop cohort, engaged daily in homework assignments that employed the use of their Pearson eText and supplemental electronic companion, MathXL. The MathXL program allowed teachers to individualize assignments, providing direct and instant feedback to students while they worked to solve problems online. Similarly, teachers used the data analysis component to assist in progress monitoring and lesson planning. In place of going over every homework problem when students returned to class, Math teachers generated a report at the beginning of class providing real-time data that detailed which concepts needed to be reinforced or retaught, saving time by sidestepping concepts that students had mastered. Phillips (2016) describes the power of tapping into the integrated forces wherein technology, pedagogy, and content knowledge, come together (TPACK). The use of technology with intentional, strategic purposes, the author writes, does much more than change the learning medium. By developing communities of practice, schools can develop the tools to make learning easier and teaching more effective and efficient.

To a lesser degree, English teachers likewise employed the use of laptops and electronic resources. The most basic measure of how laptops are used looks at how often they are used. Frequency of use has been shown to have a direct correlation with improved achievement scores across many studies of laptop programs (Addis & Faulk, 2010). Interestingly enough, Reading and writing are taught by the same teachers in the same classrooms as components of English Language Arts courses at the high school used for this study. However, Reading performance improved for the laptop cohort while Writing scores did not. Klein & Camera (2015) explain how a national emphasis has been put on Math and Reading as are result of the federal No Child Left Behind Act. As a result, more time is spent in schools boosting Reading scores at a cost to time placed on Writing instruction. The disparity between Reading and Writing performance illustrated in this study is consistent with subtest scores reflected on this school's ACT results. It is inconsistent, however, with the majority of studies on the topic showing gains in Writing performance to be most common in association with 1:1 laptop programs. Recognizing the notable shortfall in Writing skills, this school has since taken on a writing across the curriculum initiative. Still, with the absence of Writing scores reflecting a significant upward movement within performance categories on the OGT for this study, additional research is needed to help uncover the difference in instructional practices as it relates to student performance on Writing assessments.

For Reading, Writing, Math, and Social Studies instruction, the teachers, the standards, and the content were the same with the only difference being the addition of laptops and eTexts for the laptop cohort. For Science, however, two factors may have impacted student performance and might help to explain why Science did not realize significant gains similar to Math and Reading. First, the special education Science teacher instructing the most cognitively delayed students in the laptop cohort was new. This teacher was hired following the retirement of a veteran teacher who taught this sub population of students in the no laptop cohort.

And second, the Science teacher who taught all other 10th grade students was on an extended maternity for the majority of the months leading up to the 2014 administration of the OGT. This teacher returned for a full year of instruction prior to the 2015 OGT testing. As a result, 10th graders in the no laptop cohort had two different substitute teachers for their Science class instruction during the months leading up to their March test administration. Still, the difference between cohorts with regards to Science performance within achievement categories is insignificant as discussed in chapter four. One other contextual factor discussed in chapter two may have additionally impacted our results. The teacher who had been out on an extended maternity leave missed out on the professional development provided for the other subject area teachers in 2014, leading up to program implementation in 2015. As a result, this teacher came back to her 10th grade students with laptops and eTexts in 2015 and was unequally prepared to use them effectively. Professional development or teacher preparedness is a key factor recognized in the successful implementation of laptop programs (Klieger, Beh-Hur, & Bar-Yossef, 2010). It is important to note that this same teacher saw much improved student performance with her second year using laptops and eTexts in 2016 (not part of this study), when her students with laptops took the first administration of the new state AIR online state assessments in Science. Again, follow-up studies with longitudinal analysis will help us to better understand this phenomenon as it pertains to laptop programs and Science achievement tests. Still, contextual factors such as teacher preparation, along with frequency of use and the specific, targeted use of electronic resources must be taken into account and may help to explain why gains identified in Math and Reading were not similarly evident in Science.

As with Writing and Science, Social Studies scores did not realize a significant movement among performance categories for the treatment group (laptop cohort). Research on the topic of laptop programs and Social Studies achievement test results is sparse at best. In the very few cases where one can infer the consideration this discipline, it is only part of an inclusive statement indicating, for example, that students with laptops outperformed their peers across all core subject areas (Arguenta et al., 2011; Sauers & Mcleod, 2012), or that no academic gains were observed across disciplines (Hu, 2007). Little anecdotal evidence is available accompanying this study to help explain why Social Studies scores in the laptop cohort remained statistically unchanged for the laptop cohort. One potentially influencing factor relates to what the Social Studies teacher described as students being burnt out on testing. Students in the laptop cohort who took the Social Studies OGT also had to take the new online AIR assessments in two separate testing sessions. While these AIR tests did not count toward their graduation requirements, all 10th graders in the state of Ohio were required to take the “interim” Social Studies tests as a pilot assessment in addition to the OGT Social Studies assessment required for graduation (Ohio Department of Education, 2013). Social Studies was the only content area where the interim assessments were required and it was administered in February, only weeks prior to the Social Studies OGT administration. Students also had to take regular assessments for their class grades which were near the end of the grading term.

And in the sequence of tests administered during OGT week, the Social Studies OGT took place on Friday and was the last of the five OGT tests administered. Indeed, students may have been burnt out on testing by the time they took the Social Studies OGT.

Revisiting OGT Performance in Context of County and State Trends

At this juncture, it may be worthwhile to revisit the five-year trends for the OGT scores, as illustrated in Chapter 3, comparing the school's passage rate trajectories for each content area subtest to that of Columbiana County and also the state of Ohio. For the laptop cohort, 2015 OGT Reading and Writing passage rates shown in Figures 2 and 3 indicate a sharp increase in performance for the school studied, while the county saw a moderate decline and state as a whole saw a sharp decline in passage rates. According to the analysis in this study, the performance of the laptop cohort showed only a trend toward improvement over expectations in Reading, while showing no difference from expectations in Writing performance. Considering the county and state performance decline on the same tests for the same year, the improved performance of the laptop cohort on the Reading and Writing OGT tests might be even more significant than determined when only considering the actual performance of the laptop cohort against its own expectations.

Five-year trends for OGT Math , as shown in Figure 4 (Chapter 3), shows an increase in passage rates for the 2015 laptop cohort over the 2014 no laptop cohort. This improved passage rate for this school runs parallel to the improved passage rate observed for the county's OGT Math tests, while running counter to a moderate decline in passage rates across the state for the Math OGT. In this study, Math performance for the laptop cohort was determined to be better than expected, with significantly more scores falling in the Advanced category.

Trends for Science and Social Studies subtests are reflected in Figures 5 and 6 (Chapter 3). These passage rates for the school were very similar to the county and state, in spite of the laptop program. This suggests that while the impact of the laptop program may have been more significant for Writing, in addition to Reading and math, the absence of significant gains in Science and Social Studies remain a question for further study. For all five content area subtests, a longitudinal study with controls for contextual variables is needed to better understand the impact of the laptop program on student achievement as measured by Ohio's state testing instruments, while accounting for a potential implementation dip.

Research Question #3

Does participation in the 1:1 laptop program affect OGT scores in Reading, Writing, Math, Science, and Social Studies among 10th grade economically disadvantaged students? As the analysis discussed in Chapter four shows, the numbers of scores falling in the various performance level categories for each of the five subtests does not stray from what is expected of the economically disadvantaged subgroup in the no laptop cohort. Three points of impact, however, were identified in the distribution of ED scores for the laptop cohort. First, nine ED scores fell in the Accelerated category for the Reading OGT while only six were expected. Though the upward movement of these scores can only statically be referred to as a trend (p=.085 and effect size Cramer's V = .335), the positive trend is evident for Reading. Second, Math scores in the laptop cohort moved significantly in a positive direction with more ED scores (9) falling in the

Advanced performance category (*p*=.045) than expected (5.6). Third, and reciprocal to the increase of Advanced level scores, there was a significant decrease in ED scores falling in the Basic category (Expected=3.2, Actual=0). Again, we must use caution due to the sample size and related small effect size. Countering this caution, however, we know two things: One – Yates, Moore, and McCabe (1999) affirmed that under circumstances met by our data and discussed in chapter four, we can accept the significance determined by the analysis for Math performance even though the effect size is small. Two, we are reminded again that this was the first year of the new laptop program. As such, there was likely an implementation dip impacting all scores to some degree, including those in the subgroup of economically disadvantaged students.

Without question, the positive trend for Reading and significant gain for Math within OGT performance categories indicate a notable impact on the ED subgroup in relation to the laptop program. And similar to the evaluation of performance categories for the entire laptop cohort, ED scores do not appear to have been impacted by the laptop program for the subtests of Writing, Science, and Social Studies. As our findings for ED scores are consistent with our findings for the entire laptop cohort, our discussion about why the findings may have occurred is likewise similar. Based on our review of literature, any gains or non-apparent implementation dip can be attributed to the individualized and interactive features of the electronic resources accompanying the eTexts used by students (Kim, 2015). Frequency of use (Addis & Faulk, 2010), instructional methods (Twinning et al., 2014), and teacher preparedness/professional development (Klieger, Beh-Hur, & Bar-Yossef, 2010) must also be considered as contextual factors in explaining why the impact of the laptop program appears greater for

Math and Reading than for Writing, Science, and Social Studies. These contextual factors described under question two for the entire laptop cohort hold true for the scores of economically disadvantaged students within that cohort as well.

The Change Process

In recognizing a degree of success purported as part of this study, and considering the reality that many 1:1 programs fail and disappear shortly after implementation (DuFour, 2007), consideration of the implementation process for the 1:1 program studied herein is warranted. Several important elements affirmed by research contributed to the outcomes of this study. First, changing a pedagogical model takes time (Fajebe, Best, and Smyth, 2013). The school worked for eighteen months in preparation for the program initiation. Textbook representatives from several companies came to the school to demonstrate the interactive features and usability of electronic textbooks for each of the four core content areas. A 1:1 Team was formed to meet monthly to progress through a series of anticipated obstacles and potential solutions (Jouneau-Sion & Sanchez, 2013). Figure 8, found in Chapter III provides a flowchart of questions raised at the initial 1:1 team meeting. The building principal, technology coordinators, and teacher representatives from each of the core subject areas served on the team. Netbooks, tablets, and Chromebooks were researched and explored before deciding on full-functioning laptops. A subcommittee researched policy handbooks adopted by other schools with 1:1 programs. A handbook and agreement form was developed and adopted by the board of education. And, an evaluation of the Wi-Fi capacity was conducted and access points were added to meet anticipated needs (Guimarães et al., 2013).

Second, using a quasi-pilot model, it was decided to give laptops to each freshman class who would then take their laptops with them as they progressed through subsequent grade levels. In this sense, the freshman English, Math, Science, and Social Studies teachers and their students served as the pilot group. This was the laptop cohort of students who then took the OGT as sophomores in 2015. Using one grade level for the first year, it allowed teachers to work out the challenges that emerged with a smaller group of teachers. Each year after, another grade level of teachers was added with laptops and e-Texts, building on the successes and adjustments made the prior year. An outline of the *Implementation Schedule for 1:1 Roll-out* is discussed in Chapter III as reflected in Table 14.

Third, eText training was provided over the summer prior to implementation, with trainers providing professional development for teachers within their specific content area (Klieger et al., 2010). Additional follow-up trainings were provided during the school year as needed for programs such as MathXL. Monthly meetings of the 1:1 Team provided for collaborative problem solving and a sharing of best practices (Greaves, Hayes, Wilson, Gielniak, & Peterson, 2010).

And finally, sustainability was built into the budget at the onset. Monies traditionally used for the five-year textbook replacement cycle was moved to purchase electronic textbooks with six-year licenses. Budgeted funds for the replacement of classroom computers was became available for the purchase of refurbished laptops with five-year warrantees. As each student had her/his own laptop, classroom computers were no longer necessary.

Statistical vs. Practical Value

When all is said and done, at the crux of research on the topic of 1:1 laptop programs is the hope of answering one question: Is it worth the cost to cash-strapped schools to purchase laptops for every student? James (2010) declares – no, while Battro (2013) argues that we cannot afford otherwise. November (2012) weighs in suggesting that we cannot afford to go down this road without a genuine focus on the fidelity of our aim for improved instruction and learning. While this study suggests that there is statistical evidence of significance to support the notion that Math and Reading improve in relation to the laptop program, the research contends that a genuine practical value is also recognized and that it goes well beyond achievement test scores. Three points of practical significance are noted. First, students are engaged in collaborative assignments, using web-based mediums for accessing information used to problem-solve and also to assess concept mastery. Twenty-first century skills are being honed. Second, the data analyzed for this study was based on the first year of the new laptop program. The program has continued to grow with all students in grades 9-12 having laptops as of the 2-16-17 school year. Laptops are on their way to becoming "ubiquitous" at this high school (Weiser, 1991). And third, among the arguments for program implementation was the preparation for the new online assessments replacing the OGT and now required for graduation. With every student having her/his own laptop, the logistics of mass testing online are not an issue. More importantly, students are using online technologies daily, developing the skill level and general comfort to succeed with online state tests. Agreeing with Battro (2013) and November (2012), the value of the program studied in this setting is unquestionably sound. Yes – it is worth it, both statistically and practically.

Conclusion

This study indicates that the potential for increased student achievement specific to state achievement tests does exist with 1:1 laptop programs. While this study highlights the most significant gains as occurring in Math and to a lesser statistical degree Reading, previous findings from the body of research indicate that the gains realized are most likely to be in Writing, with some evidence to suggest lesser gains in Reading, Math and Science. Prior research specific to Social Studies achievement test performance as it relates to laptop programs was not found. The results of this study suggest that overall passage rates on the state OGT tests do not appear to be significantly impacted in the first year of the laptop program. Within the specific subtests of Reading, Writing, Math, Science, and Social Studies, this study suggests that a greater and more significantly positive impact of the laptop program is evident with Math scores, and to a lesser degree, Reading scores trend toward a significant improvement, with no observable impact of Writing, Science, or Social Studies scores. The results of this study also concur with research pertaining to at-risk groups such as economically disadvantaged students (ED), whereby some of the most significant improvements occur with this subgroup population. This was particularly true for Math and Reading achievement scores as evaluated in this study. Analyses of the performance categories for the frequency in which scores fall have aided in better understanding with whom and in which subject areas the 1:1 laptop program might influence positive gains in achievement at the rural high school.

These findings lend voice to the growing discussion about the viability of these programs and the debate over the cost versus benefit. The results of this study also provide a foundation from which future research can further explore the question of which related contextual factors might most significantly contribute to measured results. Among the factors to consider in future research include the 1:1 laptop program implementation process, teacher preparation, instructional practices, and frequency of use. In closing, this study sought to identify what relationships exist between the 1:1 laptop program at one rural Ohio high school and the achievement of its students, so that subsequent research can explore the nature of why relationships do or do not materialize. This study also provides a baseline for what could foster a longitudinal study to better understand the impact of the 1:1 program over time. Going beyond the first year of the laptop program in evaluating achievement test scores, a longitudinal trend analysis might best serve to correct for the potential “implementation dip” (Fullan, 2001; Mouza, 2008). There is also a notable research deficiency in the area of the implementation process and also the specific content area of Social Studies, wherein much is to be studied and learned about how positive outcomes can be realized with the integration of these technologies.

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APPENDIX A.

IRB EXEMPTION APPROVAL LETTER

Youngstown
STATE UNIVERSITY

One University Plaza, Youngstown, Ohio 44555
Office of Grants and Sponsored Programs
330.941.2377
www.ysu.edu

January 19, 2016

Dr. Jane Beese, Principal Investigator
Mr. William F. Young, Co-investigator
Department of Educational Foundations, Research, Technology & Leadership
UNIVERSITY

RE: HSRC Protocol Number: 026-2016
Title: 1:1 Laptops in Education and Achievement Test Results in One Rural High School

Dear Dr. Beese and Mr. Young:

The Institutional Review Board has reviewed the abovementioned protocol and determined that it is exempt from full committee review based on a DHHS Category 1 and 5 exemption.

Any changes in your research activity should be promptly reported to the Institutional Review Board and may not be initiated without IRB approval except where necessary to eliminate hazard to human subjects. Any unanticipated problems involving risks to subjects should also be promptly reported to the IRB.

The IRB would like to extend its best wishes to you in the conduct of this study.

Sincerely,

Mr. Michael Hripko
Associate Vice President for Research
Authorized Institutional Official

MAH:cc

c: Dr. Charles Vergon, Chair
Department of Educational Foundations, Research, Technology & Leadership