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Effects of a One-To-One Computer Environment on Student Academic Achievement

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Concordia University–Portland

College of Education

Doctorate of Education Program

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Effects of a One-To-One Computer Environment on
Student Academic Achievement

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Concordia University–Portland
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Dissertation proposal submitted to the faculty of the College of Education
in partial fulfillment of the requirements for the degree of
Doctor of Education in
Higher Education

Jillian Skelton, Ed.D., Faculty Chair Dissertation Committee
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Concordia University–Portland

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Abstract

A gap exists in current research due to a lack of studies that explore the effect of schoolwide one-to-one computer implementations on academic achievement. The purpose of this study was to determine the effect a one-to-one computing environment had on student academic achievement means of middle school students in rural Nevada. This quantitative, non-experimental study used a causal-comparative design and analysis of academic achievement archival data from the 2015–2016, the year before implementation; 2016–2017, the first year of one-to-one implementation; and 2017–2018, the second year of implementation. Two research questions guided this study: RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not? and, RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and those that did not? This study was conducted at a rural middle school with a total sample population of 1,344 students between the two years of study. The data showed that a one-to-one computing environment had no significant effect on students' end-of-year grade point average means comprised of semester grades in math, English, social studies, and science. The results of this study call for further research into the effect a one-to-one computing environment has on academic achievement means, especially student GPA means.

Keywords: one-to-one computing environment, academic achievement, GPA, SBAC

Dedication

This is dedicated to my beloved Gidget and Grandma Glade.

Thank you for loving me unconditionally.

You two will always be in my heart!

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The old adage, *it takes a village to raise a child*, comes to mind as I think of all the many angels that have helped me on this six-year journey. First and foremost, I must thank my Heavenly Father and elder brother Jesus Christ. They have blessed me immensely and I dedicate my life of being a servant leader to them. Second, my 17-year-old furry companion, Gidget, has literally been there every step of the way. She has kept me company until the wee hours of the morning trying to get assignments submitted and comforted me when the going got tough.

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Chapter 1: Introduction

Introduction

Technology has entered the educational arena and is changing how teachers teach and students learn. Prensky (2015) devised the term “digital natives” to describe students born into the digital age, with computers, gaming, and the internet always at their disposal. These digital natives, born after 1980, have grown up with a digital culture of games, phones, music and other technological devices that can go anywhere and connect in seconds with people throughout the world (Palfrey & Gasser, 2013; Prensky, 2015; Spanos & Sofos, 2013). Education has been one of the areas where technology has not kept pace with the digital native’s lifestyle and debate about the necessity for educational reform to meet student’s needs has ensued (Bennett, Maton, & Kervin, 2008; Sheninger, 2014; Xiaoqing, Yuankun, & Xiaofeng, 2013).

Kivunja (2014) and Prensky (2012) posited that teachers must cross the digital gap and learn to communicate in the language and style of their students. Sheninger (2014) further posed that administrators must use digital leadership by integrating technology in their schools to prepare students for a global, interconnected world. Technology is the digital native’s main language, so utilizing technology as a form of pedagogy has come about through integration of one-to-one computer initiatives (Cuban, 2006; Palfrey & Gasser, 2013).

One-to-one computer implementations have been occurring since the early 1990’s (Cuban, 2006; Spanos & Sofos, 2013), but little is known about how student academic achievement is impacted when all students and teachers have their own laptops at their disposal (Fleischer, 2012). Gillard (2011) stated that observed quantitative connections between one-to-one computers and student achievement are difficult to find. The purpose of this research was to determine the effect a one-to-one computing environment had on student academic achievement

means at a middle school campus in rural Nevada. This quantitative, non-experimental study used a causal-comparative design and analysis of academic achievement archival data from the 2015–2016, the year before implementation; 2016–2017, the first year of one-to-one implementation; and 2017–2018, the second year of implementation.

Background of the Problem

Traditional ways of educating digital natives are not working. Antiquated methods are not allowing digital natives to reach their highest potential. Kivunja (2014) stated that “teaching learners without a firm grasp of how they learn is like trying to erect a building on shifting sand” (p. 95). Education must begin to understand how digital natives learn best (Kivunja, 2014; Prensky, 2012; Sheninger, 2014). This may be one of the reasons that college retention rates are dropping and why researchers estimate 40–60% of high school students must take remedial courses in math and English their first year of higher education (Jimenez, Sargrad, Morales, & Thompson, 2016). If digital natives are beginning education with deficits and those insufficiencies are only growing larger over time, there is a problem and education must look for ways to digitally connect with students and expand the use of technology (Kivunja, 2014; Prensky, 2012; Sheninger, 2014). One such method that is currently being used by schools is one-to-one computer implementation that puts technology into the hands of students and teachers for use at school and home (Clarke, 2016; Heath, 2015; Palfrey & Gasser, 2013; Roberts, 2008; Smith III, 2014).

Advancements in technology continue to make computers more accessible. In 1965, Gordon Moore, one of the founders of Intel, predicted that the processing speed of computers would double every 24 months (Moore, 1965). For the past 50 years that prediction has held true as computers have gotten faster, smaller, and more portable. Twenty years ago, schools needed

entire labs that cost tens of thousands of dollars, but now there are more affordable laptops and tablets that have made the idea of providing a device for every student more of a reality (Harold, 2015). The Internet and wireless networking have also provided access to information and the ability to create mobile classrooms that are more conducive to the life of a digital native (Sheninger, 2014). Laptops allow a student to connect wirelessly and be disconnected from the computer lab, library, or the wall and go anywhere inside or outside of a school building to learn (Sauers & Mcleod, 2012). Serwe (2005) introduced the concept of “hot spots” where free wireless Internet access was offered by businesses or other entities. Thirteen years later, free Wi-Fi is part of life and many students have phones that act as hot spots for their laptops or tablets. With the invention of apps and cloud storage, computers like Google’s Chromebook, which does not need a hard drive and runs completely off apps and the cloud, schools are seeing more affordable options to providing one-to-one devices for their students to access 24/7 (Harold, 2015).

Some of the main concerns of a one-to-one computing environment are funding, procedures, implementation, management, and teacher professional development (Clark, 2016; Grant, 2016, Hayes & Greaves, 2013; Roberts, 2008; Topper & Lancaster, 2013). Even with all the advances in technology, schools and district leaders may struggle to find the funds to provide a laptop for each student (Hayes & Greaves, 2013; Topper & Lancaster, 2013). There are also long-term issues such as repair, routine maintenance, and replacement that need to be budgeted up front (Bosco, 2015; Topper & Lancaster, 2013). Answering questions such as how students and parents are held accountable and who has the time to manage the financial logistics of running a one-to-one program are important considerations (Bosco, 2015; Roberts, 2008,

Scheninger, 2014). Knowing who is responsible for each aspect and how the laptops will be managed is imperative to implementation (Bosco, 2015; Sheninger, 2014).

While digital natives are comfortable with technology, many teachers are not, causing fear and frustration when one-to-one implementations are made (Roberts, 2008, Sheninger, 2014). Using technology to facilitate the educational process is something very foreign and frustrating to many educators (Clarke, 2016; Dyck, 2006; Grant, 2016). Staff development must be well thought out for successful implementation of one-to-one laptops in a school (Clarke, 2016; Grant, 2016; Simmons, 2015; Topper & Lancaster, 2013). There are also concerns regarding the time it might take to convert a teacher's established curriculum to a digital format (Fleischer, 2012, Pennuel, 2006). Providing time to learn, plan, and discuss must be built into the intended one-to-one implementation timeline (Bosco, 2015; Grant, 2016; Sheninger, 2014). The logistics of running the program from an administrative perspective, classroom level, and then at home can seem overwhelming.

A survey of 364 administrators from large school districts with one-to-one computer initiatives reported that 78% of school leaders felt laptops had a moderate or significant effect on student achievement (Gillard, 2011; Goodwin, 2011). While there have been many research studies conducted on one-to-one computer implementation, few have looked at student academic achievement, focusing instead on development of computer skills or program implementation, and limiting participation to only one grade level or subject area (Crooks, 2016; Hile, 2015; Spanos & Sofos, 2015; Storz & Hoffman, 2013; Suhr, Hernandez, Grimes, & Warschauer, 2010). Fleischer (2012) conducted a literature review of one-to-one computer initiatives and concluded that the correlation between one-to-one computers and student academic achievement was ineffectual and inconclusive. The need for a study that concentrates on the correlation

between one-to-one computers implemented in an entire school and student academic achievement is long past due (Clark, 2016; Pennuel, 2006; Storz & Hoffman, 2013).

Problem Statement

The effect a one-to-one computing environment has on student academic achievement means are not apparent or known (Clark, 2016; Fleischer, 2012; Pennuel, 2006; Storz & Hoffman, 2013). Academic achievement is an indicator that is used to evaluate not only the future success of the individual student, but the effectiveness of the school and the nation in comparison to other countries (Dev, 2016; Huang, 2008; Spanos & Sofos, 2015). Yamaguchi, Sukhbaatar, Takada, & Dayan-Ochir (2014) concluded that even though the educational rationale for one-to-one computing programs is based on improving the quality of education by increasing student achievement, 21st century learning skills, and internal efficiency, the actual impact of one-to-one device programs on academic achievement is not known. Technology is expensive and finding the funding to provide a one-to-one ratio is a challenge (Bosco, 2015; Hayes & Greaves, 2013; Topper & Lancaster, 2013). Administrators, teachers, stakeholders, and policymakers need to see student academic achievement results from public institutions where one-to-one implementation has been accomplished to decide on future use of individual devices for students and teachers, making research in this area vital (Clark, 2016; Pennuel, 2006; Storz & Hoffman, 2013).

Purpose of the Study

The purpose of this research was to determine the effect a one-to-one computing environment has on student academic achievement means at a middle school campus in rural Nevada. This quantitative, non-experimental study used a causal-comparative design and analysis of academic achievement archival data from the 2015–2016, the year before

implementation; 2016–2017, the first year of one-to-one implementation; and 2017–2018, the second year of implementation. The researcher sought to address the gap in the literature that exists in studying academic achievement in the form of grade point averages (GPAs) and Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Tests at the middle school level for entire school one-to-to-one device implementations. Additional goals of this study were to add to the body of research on the impact of one-to-one computer implementations on academic achievement at any level, to inform future implementation decisions made by stakeholders of school districts deciding on one-to-one computers, and to provide future researchers with gaps in the data within the scope of academic achievement and one-to-one computer implementations.

Research Questions

The research questions in this study to explore the effect a one-to-one computer environment has on academic achievement included:

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

Hypotheses for GPA Scores

H1₀. There is no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between

middle school students who participated in a one-to-one computing environment and students that did.

H1_a. There is a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

Hypotheses for SBAC Scores

H2₀. There is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

H2_a. There is a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

Significance of the Study

The significance of this study was to provide data on the effect a one-to-one computing environment has on student academic achievement mean scores. According to Cooper (1993), a shift in theory for designing instruction in education has moved from behaviorism to cognitivism and now constructivism. The theory that was the basis for this study is the learning theory of constructivism. Constructivism “equates learning with constructing meaning from experience” (Cooper, 1993, p. 13). Constructivism was chosen as a conceptual framework for this study because it represents a shift in epistemology of knowledge and theory of learning and is undoubtedly one of the most influential perspectives of learning to impact education during the

last 20 years (Applefield, Huber, & Moallum, 2001). One-to-one computing embodies constructivism in principal and significance for pedagogical methods.

One-to-one computer implementations have been occurring since the early 1990's (Cuban, 2006; Spanos & Sofos, 2013), but little is known about how student academic achievement is impacted when all students and teachers have their own laptops at their disposal (Fleischer, 2012). Observed quantitative connections between one-to-one computers and student achievement are difficult to find (Gillard, 2011). Suhr et al. (2010) posited that to date much of the research that has been done on one-to-one computer implementations has been lacking in study of the implications on test outcomes. Research has focused on computer competence and skills or the perceptions of students and teachers about laptop use instead of specific academic gains (Storz & Hoffman, 2013). Crooks (2016), Hile (2015), and Stortz and Hoffman (2013) used a qualitative approach and focused more on the experience of how technology was perceived by students and teachers and if teaching styles or instructional practices were affected by a one-to-one computer implementation rather than on how academic achievement was effected. There are still numerous gaps in the data on one-to-one computing environments and academic achievement (Fleischer, 2013), as well as conflicting data throughout the current research studies that often contradict each other (Clark, 2016).

The future applications of the study show meaningful significance. Educational institutions may take the results of this study and use them to enhance the one-to-one computing environment on an individual classroom level as well as a school-wide level. Administrators may take the results to write school improvement goals. Teachers may take the results to examine the academic success of the pedagogical methods they are using in their classrooms with regards to technology, which may result in curriculum changes. The results of the study may provide school

districts with an idea of what to expect from a school-wide one-to-one implementation and allow them to create stronger planning stages that focus on student achievement. School board members, legislators, and government officials may see the value of one-to-one computing devices within schools and find ways to budget and fund for broader implementation.

This study sought to fill the gap in the literature by providing needed data on the effect a one-to-one computing environment has on student academic achievement mean scores in the form of end of year grade point averages (GPAs) and SBAC Math and English Language Arts/Literacy Test scores, which are the Nevada State standardized tests. Additionally, this study focused on the lack of existing research on schoolwide one-to-one implementations, specifically at the middle school level. The significance of the study was to examine the gap that exists in the literature for schoolwide one-to-one computer implementations where academic achievement is concerned, be practical in application, and in a constructivist sense, add further knowledge and credence to the study of schoolwide one-to-one computing environments.

Assumptions

Simon (2011) purported that assumptions are aspects of a study that the researcher believes to be true or clear. It was assumed that the final grades for each student were reported accurately allowing for the researcher to put them into an Excel spreadsheet and calculate GPAs on a standard 4.0 scale. Furthermore, it was assumed that the administration of the SBAC Math and English Language Arts/Literacy Tests was completed with fidelity to the prescribed protocols put into place to ensure a uniform delivery to the students and that the results reported to the State of Nevada were reliable and valid. Reliability coefficients for the SBAC tests can be found in Table 1 of the instrumentation section in Chapter 3.

Additionally, the researcher assumed that all data from GPAs and SBAC tests used as the dependent variable of academic achievement, was numeric, continuous, and based on a normal distribution (Laerd Statistics, 2015a). The observations of the study years are assumed to be independent of each other and the dependent variable of academic achievement is to meet the assumption of normality and equal distribution as shown by histograms. If any outliers are present in the academic achievement data sets, the researcher assumed they occurred normally due to variability and not error.

Delimitations

Adams and Lawrence (2016) described delimitations of a study as the boundaries that are set by the researcher to test the hypotheses. Delimitation consisted of only two research questions and defining academic achievement in two ways: (a) students' end-of-year grade point averages comprised of semester grades in math, English, social studies, and science; and (b) students' scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests. The researcher delimited the study to sixth through eighth grade students at two middle schools located in rural Nevada. Only research data from students who were enrolled in grades six through eight at Middle School A were used in the study. Delimitation of Attendance and GPA data by the researcher consisted of comparing the 2015–2016 school year without the Chromebooks and the 2016–2017 school year with the one-to-one implementation of the Chromebooks.

Limitations

Limitations are constraints beyond the researchers control that could affect the outcome of the study (Simon & Goes, 2013). The study was limited by the number of public middle schools that were awarded the Nevada Ready 21 Grant in Nevada. Middle School A was

awarded the grant and had a population of approximately 680, but with the advancement of each student to the next grade and the transitory nature of enrollment, the students will be in different grades from the year before implementation to the first year of implementation. Some students did not participate because they were in fifth grade for the year before implementation. There were also students that were in eighth grade for the year before implementation that moved to ninth grade for the first year of implementation and were only part of one year of the study. The online SBAC was in its first two years of implementation during the study years, so the State is still trying to improve upon the administration. Each of these limitations could affect the data to some degree.

Summary

Chapter 1 included an introduction of one-to-one computing and a foundation for the study by detailing the following components: background of the problem, problem statement, purpose of the study, research questions, significance of the study, and limitations of the study. Chapter 2 presents literature related to one-to-one computing by exploring digital learning, mobile learning overview, one-to-one computing, the mobile device dilemma, positive impact on learning, challenges for implementation, suggestions for smoother implementation, and evaluating program success. Chapter 3 provides the methodology that will be used by the researcher to complete the study and presents the purpose of the study, research questions, hypotheses, research design, target population, sampling method and related procedures, instrumentation, data collection, operationalization of variables, data analysis procedures, limitations and delimitations of the research design, internal and external validity, expected findings, and ethical issues in the study. In Chapter 4 of the study, the researcher will present the

data collected for this study. Chapter 5 will contain a discussion of the study, recommendations for future research, and a conclusion.

Chapter 2: Literature Review

Introduction

Even though technology has flooded society and has been a part of educational initiatives for some time, one-to-one computing is still in its infancy as far as pedagogical theories are concerned. Little research exists on the effect a one-to-one computer environment has on academic achievement with regards to grade point average and standardized testing (Fleischer, 2012), especially at the middle school level. “One-to-one computing in public schools” (2008) reported administrators and educators demonstrated hope for one-to-one device programs to increase academic achievement and student engagement, while reducing the digital divide by increasing the economic competitiveness of students through acquisition of 21st century skills.

The goal of this review of literature is to evaluate the available research regarding the effect a one-to-one computer environment has on academic achievement means. This chapter begins with a discussion of the conceptual framework, followed by a review of research literature and methodological literature beginning with the search strategies used. Next an overview of digital learning, mobile learning, and the history of one-to-one computing are discussed. In addition, the mobile device dilemma is examined along with the positive impact on learning and challenges for implementation. Suggestions for smoother implementation and evaluating program success of one-to-one implementations are explored. Finally, a review of methodological issues, a synthesis of past research findings, and a critique of previous research are presented.

Conceptual Framework

The theory that was the basis for this study is the learning theory of constructivism. In the last two decades education has experienced a shift in thought about the way humans learn and

the conditions which allow learning to occur (Applefield, Huber, & Moallum, 2001).

Constructivism “equates learning with constructing meaning from experience” (Cooper, 1993, p. 13). The shift in theory that has been increasingly used in designed instruction in education, has moved from behaviorism to cognitivism and now to constructivism (Cooper, 1993).

Constructivism as a paradigm shift posits that learning is an active, constructive process (David, 2015). Constructivism was chosen as a conceptual framework for this study because it represents a shift in epistemology of knowledge and theory of learning and is undoubtedly one of the most influential perspectives of learning to impact education during the last 20 years (Applefield, Huber, & Moallum, 2001). Constructivism also utilizes cooperative learning groups to teach multiple perspectives and problem solving by creating critical thinkers who possess 21st century student skills that engage in real world activities and problem-based learning.

Constructivism is not an entirely new conceptualization of the learner and of the learning process (Applefield et al., 2001). Roots can be traced to Piaget, Vygotsky, and Bruner, who were all considered progressive educators, and Dewey who was known as a philosopher, psychologist, and educational reformer (David, 2015). Piaget (1952) watched his own children and how they made sense of the world around them. This resulted in a four-stage model that follows a chronological pattern of the child’s progressing age and includes interactions with the environment, classification of objects, thinking abstractly and conceptualization to explain physical experiences, and finally reaching the cognitive form of deductive and hypothetical reasoning (Piaget, 1952).

Vygotsky’s social development theory is one of the foundations for Constructivism theory (David, 2015). Vygotsky (1980) promoted learning contexts in which students take a more active role in their learning. Roles of the teacher and student are shifted in collaboration

with each other to help facilitate the process of “making meaning” (Vygotsky, 1980). Learning utilizes a higher order of thinking and process skills allowing a reciprocal experience between the students and teacher (David, 2015).

Discovery learning is an inquiry-based constructivist learning theory that was developed by Bruner (David, 2015). Bruner (2009) built upon Piaget’s idea of increasing cognitive experiences with his discovery theory that focuses on problem solving situations where students interact with the world around them by performing experiments, manipulating objects, or wrestling with questions and controversies. The learner draws upon past experiences and knowledge to discover new information, facts, and truths to be learned (Bruner, 2009). This type of learning has a greater capacity for promoting guided discovery through problem-based learning, which in turn will result in a stronger likelihood that a student will remember concepts and knowledge discovered on their own (Bruner, 2009). Bruner (2009) felt that this type of learning style better promoted active engagement and motivation in learning, while tailoring a student’s experience through creativity and problem solving.

Dewey’s contribution to constructivism begins with his term active learner, which is formulated on the belief that learning is an active process where the learner uses sensory input and constructs meaning out of it (Hein, 1991). Ultimately the learner must not only accept the knowledge that exists but do something and actively learn from engagement with the world around them (Hein, 1991). Dewey also coined the term reflective activity to describe engaging the mind as well as the hands, as he believed that hands-on experience might be necessary for children, because physical action would never lead to constructing meaning without the mind being actively involved in the learning process (Hein, 1991).

When considering the contributions of Piaget, Vygotsky, Bruner, and Dewey, it becomes clear that a one-to-one computer implementation that looks specifically at student achievement follows a constructivist learning theory. Constructivism equates learning with constructing meaning from experience (Ertmer & Newby, 1993). Using an individual computer to drive one's learning and pursuit for knowledge not only benefits the student, but the teacher as well. In constructivism students are actively engaged through problem solving and meaningful contexts by taking on a more active role in their learning. The research alone that a student can do on an individual computer lends itself to broadening the information that could be brought into a classroom where all would benefit. Learning is more meaningful to students when they are able to interact with a problem or concept. Having each student on a computer would aide in a higher level of thinking and allow for the transference of ideas to solve problems that would not have been thought of with other traditional methods of pedagogy. This, in turn, could allow for greater knowledge in a subject area and result in higher grades and test scores.

Constructivism utilizes teaching strategies to create meaningful contexts that help students construct knowledge based on their own experiences. Every student has different life experiences and is at a different level of intellectual understanding. Students each have their own learning style. The principals of constructivism, such as higher order thinking skills, reasoning and problem solving, and the transfer of knowledge to new and different situations, are a components of one-to-one computer implementation that could be shown through academic achievement. There is widespread agreement in the literature that such approaches are desirable and there are numerous studies which indicate that one-to-one programs can be effective facilitators of student-centered teaching and learning (Burgad, 2008; Casas, 2002; Lowther, Inan, Ross, & Strahl, 2012; Rosen & Beck-Hill, 2012; Zheng, Warschauer, & Chang, 2016). When

students are active participants in the learning process, they are more engaged and motivated which can lead to increased student achievement (Burgad, 2008; Clark, 2016; Zheng et al., 2016).

Review of Research and Methodological Literature

The literature on mobile technology was vast. Review of the literature showed both negative and positive views exist when it comes to technology. Focus was centered on researching the history of mobile learning and the introduction of one-to-one devices into the educational realm. A search of studies showed that few quantitative studies have been conducted. The gap that emerged through perusal of the research showed that more studies focusing on the difference between one-to-one computing and academic achievement, especially GPA are needed.

Search strategy. The search of the literature was focused on the difference a one-to-one computer environment has on academic achievement. The results were more plethoric as a single topic search than with academic achievement as a secondary topic, so the search was limited to research that dealt specifically with providing a computer to all students and teachers in an educational environment. Limiting academic achievement to only grade point averages resulted in less literature and fewer studies than defining academic achievement as some form of standardized test. Attention was given to research that focused on how the computing environment affected academic achievement in the form of grades, standardized testing, staff development, and school-wide implementation. The search was conducted using Eric (ProQuest), Education Database (ProQuest), Dissertations and Theses Global (ProQuest). Wiley Online Library, and JSTOR. Keywords included: *one-to-one computers*, *one-to-one computing*

environment, one-to-one computer initiative, academic achievement, standardized tests, GPAs, grades, staff development, school-wide implementation.

Mobile Learning Overview

The digital age has revolutionized everything from phones to learning. Mobile technology has opened a whole new door to eLearning (Smith III, 2014). Globally, over six billion people have access to a handheld mobile device that is connected to the Internet and for every person who uses a computer to surf the web, two people use a mobile device (UNESCO, 2015). The Pew Research Center (2014) reported that as of October 2014, 64% of adults in America owned a smartphone, 32% of adults owned an e-reader, and 42% of adults owned a tablet computer. “According to a *2014 EDUCAUSE Report*, 86% of undergraduates owned a smartphone as of last year, and nearly half (47%) owned a tablet” (Chen, Seilhamer, Bennett, & Bauer, 2015, p. 1). The sheer number of mobile devices owned by students has opened the door for the introduction of mobile learning from K–12 to the higher education campus (Smith III, 2014). Mobile learning is a topic that is growing in popularity among scholars and researchers. Mobile learning concepts such as one-to-one computing devices, where every student and teacher have a device and BYOD (bring your own device), have been the source of initiatives to further 21st Century Learning Skills among students (Harris, 2010; Majumdar, 2015). Educational institutions that have grasped the eLearning concept are now seeing a need to explore mobile learning (Smith III, 2014). The realization by K–12 schools that eLearning is beginning to be an important part of higher education and the global job market has fueled the desire for school districts to increase the use of technology and mobile devices (Bosco, 2015; Crooks, 2016).

The Internet has made it possible for educational institutions to offer eLearning, where entire courses of study are offered online (Adkins, 2011; Wexler, Brown, Metcalf, Rogers, & Wagner, 2008). With this type of instruction, “learners are no longer limited to the classroom’s geographical boundaries, for example; students can now record raw observations and analyze data on location” (Chen, Seilhamer, Bennett, & Bauer, 2015, p. 1). A student can attend class day or night and collaborate with students in any country in the world (Smith III, 2014). Mobile technology has become an integral part of day-to-day life and has changed the way students communicate, search for information, allocate time, and learn (Chen et al., 2015; Smith III, 2014; Traxler, 2009; Wexler et al., 2008). Mobile learning has become the next logical step to advancing eLearning (Adkins, 2011; Smith III, 2014).

Mobile learning can be defined as using digital devices such as smartphones, tablets, and computers in class or out in the field (Chen et al., 2015; Simonson, 2009; Traxler, 2009). Börner, Glahn, Stoyanov, Kalz, & Specht (2010) pointed out that the literature indicates some confusion in establishing a clear-cut definition for mobile learning. Definitions tend to be technocentric (focusing on the device itself), based on the mobility of the learner, or rely on the 24 hours a day, 7 days a week, 365 days a year (24/7/365) concept (Börner et al., 2010; CoSN, 2015; Simonson, 2009; Traxler, 2009). “Students are beginning to use a combination of hardware, such as a laptop plus a digital tablet or smartphone, and Internet connection technologies, such as Wi-Fi plus cellular data, to support learning 24/7/365” (CoSN, 2015, p. 1). Since mobile learning is such a new pedagogical method and technology is constantly evolving, the definition of mobile learning is continuing to grow and shift as more and more schools are seeing the potential of the concept (Smith III, 2014). The potential impact of mobile learning may not be realized for many years, but one thing is for certain, mobile devices are here to stay.

One-to-One Computing

In 1985, Apple launched the first one-to-one computing program in two schools (Bosco, 2015). The Apple Classrooms of Tomorrow (ACOT) initiative was intended to be a long-term research project that would examine how access to interactive computer technologies cause learning and teaching to change in the classroom for both students and teachers (Apple Computer, Inc., 1991). ACOT prescribes to the philosophy that learning should be student driven and that the role of the teacher moves to that of a mentor or coach that guides the construction of knowledge by the student (Apple Computer Inc., 1991). This type of learning, where students explore how to build their own knowledge of a subject, is called constructivism (Apple Computer, Inc. 1991). In 1991, Apple Computer Inc. reported that six years of research on one-to-one computing showed that the use of microcomputers and interactive educational technologies “are most powerfully used in learning activities where children are engaged in tasks with real purpose” (p. 1). The study also showed a strong difference in self-confidence levels, problem solving skills, and positive attitudes among students that had a great deal of access to computers for learning and those who had little or no access to technology (Apple Computer Inc., 1991). Apple Computer, Inc. (1991) planned to track the continued results of constructivism in the schools which had been introduced to the one-to-one initiative.

While Apple was the leader in one-to-one computing, other computer companies saw the potential for growth and came up with their own initiatives. Microsoft’s Anytime, Anywhere Learning program flooded schools with the opportunity for students to lease or buy laptop computers in the mid-1990s (Penuel, 2006). Penuel (2006) explained that the most common concept of the early one-to-one computer initiatives was that the student had individual access to a computer no matter what administrative policies were put into place. Basically, each school or

school district could decide whether the student took the computer home, if there was a cost involved, and what program goals would be developed (Penuel 2006). Jett (2013) argued that charges or fees associated with one-to-one computers can broaden the socioeconomic status of families and potentially widen the achievement gap. A multiplicity of goals for the initiatives have been used to gain support and funds from school boards, foundations, state legislatures and corporations in an effort to improve access to technology resources for all students (Lemke & Martin, 2003a, 2003b, 2003c, 2003d).

Bosco (2015) noted that from 1985 to 2015 marked a 30-year anniversary for one-to-one computing in schools. One of the marked differences between early one-to-one initiatives and implementations today is just how far technology has progressed (Bosco, 2015; Smith III, 2014). Advancements in computer manufacturing have made it much more affordable to buy a basic computer (Markoff, 2015). Innovations in smartphones, tablets, and mp3 players have brought computing applications to be held in a hand and be accessible 24/7 (El-Hussein & Cronje, 2010; Savill-Smith & Kent, 2003). Computers have become far more portable and Internet mobility has come light years in the global world (Smith III, 2014). Handheld devices have radically changed social and economic ways of life for people reshaping expectations (El-Hussein & Cronje, 2010). There are few places that a person cannot take some sort of mobile device and connect to the Internet and thus the rest of the world. Devices such as routers, modems, and hotspots allow a person to be able to connect to Wi-Fi anywhere around the globe (Savill-Smith & Kent, 2003).

The Mobile Device Dilemma

One of the most widespread concerns schools have with mobile learning is the actual digital device and whether it will be used for good or evil. Whitby (2014) described the measures that schools implement to ban mobile devices, going so far as to install a metal detector and

security checkpoints to make sure that no one brings a mobile device into the school. Educators and administrators are fearful of what students might do with a device, such as text answers, send inappropriate pictures, or even just use the device for something other than the assigned task (Nielsen, 2011; Whitby, 2014). McCarthy (2010) stated that statements such as “turn off your phone” or “close your laptop” are being made more often by instructors at the beginning of class to get student’s attention. Wexler et al. (2008) stated that worrying about how devices can be misused seems to be counterintuitive. Whitby (2014) suggested that educators should view smartphones as accelerators instead of distractions. “A digitally literate culture in a technology-driven society should be teaching its children how to use the devices of choice to access, curate, communicate, collaborate with and create information” (Whitby, 2014, p. 2). Nielsen (2011) offered that incorporating strategies to meet the needs of today’s digital learners, and guiding students to create responsible digital use policies with clear expectations for misuse, helps students become more self-directed, motivated, and reflective about their learning.

Menkhoff and Bengtsson (2012) posed that the potential of mobile devices in the higher education setting to enrich the context of blended learning, is going completely unnoticed. Conducting spot checks has shown that students use their phones and laptops in classrooms “to exchange topical infos about the subject matter discussed by the instructor, to clarify certain terms or issues, and to provide help and guidance to locate particular resources in textbooks or online directories” (Menkhoff & Bengtsson, 2012, p. 226). Slowly educators are beginning to realize the positive potential for digital device use (Smith III, 2014). A paradigm shift in utilizing constructivism in one-to-one computer programs is beginning to occur among long-term non-digital native educators.

Research suggests that all levels of education seem to be missing the potential of individual mobile devices (Fleischer, 2012; Sauers, 2012). K–12 education has begun to allow mobile devices that are provided by the school but are slow to warm up to the idea of bringing your own device or BYOD. A 1:1 ratio of technology is always the ultimate goal, but budgets usually prohibit this. Nielsen (2011) posed that limiting student’s handheld devices is only hurting the potential for a 1:1 ratio. Allowing students to BYOD opens school owned devices to be used by students who do not possess one. “The shift in a school is for teachers and students to come together to discuss and discover the limitless possibilities that a tech-rich environment provides, and then work together to think about how to best pursue learning goals” (Nielsen, 2011, p. 2). Mobile learning is helping to narrow the gap between those born in the digital age and those who are still stunned by the change’s technology has brought to daily life (Fleischer, 2012; Smith III, 2014).

Positive Impact on Learning

Twenty years ago, payphones worked, there was limited Internet access, doctors carried pagers, laptops were heavy, and Google, Wi-Fi, and texting were not even possible (Holland, 2014). Everyone is going mobile these days, and no one knows exactly what possibilities will be available in the next twenty years (Holland, 2014). Börner et al. (2010) defined core educational concepts of mobile learning as access to learning, contextual learning, learning across contexts, collaboration, and personalization. Each one of these core educational concepts substantiates the constructivism conceptual framework for one-to-one laptop usage in educational institutions. Access to learning is one of the most substantial aspects of both one-to-one learning and constructivism. Mobile devices allow for the student to always be within grasp of knowledge (Holland, 2014; Traxler, 2009). Gone is the need for a student to run to the library for research.

Even with all the resources offered in a library, a mobile device offers much more in the way of accessing multiple libraries and an infinite number of sources (Clark, 2016, Holland, 2014; Traxler, 2009). Students can sit in class and use their mobile device to cross-reference and find additional material as the lecture is progressing (Börner et al., 2010; Holland, 2014; Traxler, 2009). Mobile learning offers the ultimate access to knowledge (Clark, 2016). Hayes and Greaves (2013) reported that to power one laptop the cost for electricity is only \$11 a year compared to \$80 per year for a desktop and when students charge their laptops at home there is an even greater savings.

Contextual learning can take place while learning across contexts (Börner et al., 2010). Börner et al. (2010) posited that through the ability to access multiple sources of information, a student can sit in a Humanities course and search for information on American History. Dimensions of importance and feasibility are realized by students in a mobile learning atmosphere, offering a stronger interaction with the student's environment (Börner et al., 2010; Clark, 2016; Smith III, 2014). A mobile device allows the student to watch videos, take pictures, access documents, or even create a graph without having to go anywhere else or get more supplies (Menkhoff & Bengtsson, 2012). A student studying global healthcare could take their mobile device with them to Guatemala and show videos to poor villagers on hygiene. The constructivist possibilities to cross contexts are endless.

The collaborative possibilities and personalization of mobile learning cross boundaries and offer diversity in a way that could never be accomplished in the traditional classroom (Börner et al., 2010; Holland, 2014; Traxler, 2009). Not only can students collaborate with other students from around the world, instructors can pull input from colleagues from other content

areas, schools, and cultures (Chen et al., 2015; Clark, 2016; Traxler, 2009). An adjunct professor can use the tutorial videos of an expert in statistics to demonstrate how to find a z-score.

Students and professors can unite together and create their own videos to promote collaborative learning on a much broader scale. Mobile learning utilizes technologies that might be impossible in a different setting, creating new forms of knowledge and ways to access it (Smith III, 2014; Traxler, 2009). The technologies employed in mobile learning allow for individual personalization, where a student that is struggling can get more support on the topic and allow another student to advance their scope of learning in a different direction (Chen et al., 2015; Traxler, 2009). There are also greater opportunities to collaborate on a global level to solve problems such as hunger, clean water, pollution, and disease (Chen et al., 2015; Holland, 2014; Smith III, 2014; Traxler, 2009). Mobile learning affords information to reach the remotest, rural areas and will allow students to use constructivism to collaborate to solve the world's problems.

Academic Achievement

Academic achievement has been an indicator of student success for many years. The first formal grading system was instituted at Yale University in the early 19th century and consisted of marking students on a 4-point scale (Lassahn, n.d.). In 1897 at Mount Holyoke College, the first letter grades that correlated with a percentage scale were used: 95 to 100 = A, 85 to 94 = B, 76 to 84 = C, 75 = D and anything below 75 = E, or a failing grade (Lassahn, n.d.). During the first part of the 20th century in accordance with compulsory attendance laws for students to attend public school, grading scales were standardized among elementary and secondary schools (Lassahn, n.d.). While there have been controversies over using letter grades and the subjective

nature of teacher's criteria in assessing grades (Lassahn, n.d.), the letter grade on a 4.0 scale as an indicator of academic achievement has stood the test of time.

Academic achievement being measured by standardized tests has evolved from educational reform over many years since the Elementary and Secondary Education Act in 1965, proposed that every child in America, regardless of socioeconomic status be given the educational opportunity to enhance growth of mind and skills with assistance from local and state school districts (United States Senate, 1965). In 1994, the Elementary and Secondary Education Act was replaced with the Improving America's Schools Act, which included stronger accountability for schools and standards-based curriculum (U.S. Department of Education, 1995). The Improving America's Schools Act mandated new educational reform components, such as standardized state tests to assess an approved standardized curriculum with benchmarks for all students to meet at a predetermined level of learning proficiency (U.S. Department of Education, 1995). Adequate yearly progress (AYP) was part of this federal education reform and was instituted to show evidence of a school's accountability of measuring achievement outcomes and was outlined with corrective actions if a school failed to adequately meet prescribed levels (Goertz, 2001; United States Congress, 1994).

Fast forward from 1994 to 2001, when the No Child Left Behind (NCLB) Act increased the mandates of school accountability for education of students with stronger sanctions against schools for not meeting proficiency levels (U.S. Department of Education, 2002). Any school receiving federal funds was mandated to test students in grades three through eight and again in high school on the proficiency of math, English, and writing. If even one of the three tests was not passed, a student would leave high school without a diploma regardless of their GPA. Sanctions such as allowing students to attend higher achieving schools, providing professional

development, replacing principals and teachers, and providing a complete restructuring plan for schools placed on a watch list were implemented (U.S. Department of Education, 2002). In an effort to meet all of the federal mandates and provide an updated, standards-based assessment that would replace disjointed, outdated assessment systems, 30 states came together in 2010 to submit a grant application to the federal government for the opportunity to create a quality on-line standardized assessment. The 30 states were awarded a \$178 million federal grant that over the next four years would make history by creating an assessment system called the Smarter Balanced Assessment Consortium that would become the most widely used assessment system in the United States (Smarter Balanced Assessment Consortium, 2018). However, while academic achievement has been defined by a standardized grading scale and standardized tests, the effect technology or specifically one-to-one computing environments has on academic achievement is not clear (Fleischer, 2012; Gillard, 2011).

Many studies have been added to the research done on one-to-one computing since the first study done by Apple in 1985. While research has added to the knowledge on one-to-one computing, there have been very few quantitative studies that have explored the connection between one-to-one devices and student achievement (Suhr et al., 2013). One reason for this may be due to the lack of longitudinal studies that have been conducted (Clark, 2016). Warschauer (2006) posed that any technology initiative takes time to fully recognize the complete impact. One-to-one computer initiatives take time, money, and planning (Burgad, 2008; Clarke, 2016; Suhr et al. 2010; Yamaguchi et al. 2014), so extensive research may be restricted or not possible at all. Alberta Education (2008) conducted a study that focused on the first year of a one-to-one computer implementation and concluded that it is difficult to assess the effectiveness of such programs in only a year. Similar results can be seen in the half-year study by Bryan (2011) that

reported no significant impact of a one-to-one computing environment on reading scores. In 2013, Storz and Hoffman concluded in their study on student and teacher perceptions of a one-to-one laptop initiative that it was too soon to look at achievement as an indicator of success and that further research should delve into long-term development of one-to-one programs in an effort to effectually assess impact. Evaluation of one-to-one device learning is necessary and should be continuous to provide for new data (Bosco, 2015; Chen et al., 2015; Clarke, 2016; Majumdar, 2015).

Challenges of Implementation

As with any new method of pedagogy, implementation comes with challenges. One of the biggest key issues to implementing mobile learning in the form of one-to-one devices is training educators (Chen et al., 2015; Hayes & Greaves, 2013; Livingston, 2012; Simmons, 2015; Smith III, 2013; Whitby, 2014). Researchers who conducted a mobile survey at Boise State University and the University of Florida “found that faculty lacked the necessary support and resources to successfully integrate mobile learning technology into the classroom learning experience” (Chen et al., 2015, p. 3). Providing training and a clear vision of the possibilities for using one-to-one mobile devices is imperative in the education setting for wide-scale institutional implementation (Chen et al., 2015; Clark, 2016; Holland, 2014; Simmons, 2015; Traxler, 2009). Holland (2014) found that her students did great with dictating and delegating but struggled because they had no concept of what collaboration actually looked like. “It became very clear that they did not know how to assume shared responsibility and value individual contributions” (Holland, 2014, p. 2). Ensuring that proper modeling and scaffolding is put into place is vital to the success of mobile learning (Clark, 2016).

In their multi-year study, Chen et al. (2015) found that deficiency of training for teachers is linked to issues such as a lack of funding, low administrative and technical support, and the absence of digital literacy agendas. Administrators must enlist the support and help of all stakeholders to create a successful mobile learning agenda that can enhance the entire campus (Chen et al. 2015; Majumdar, 2015; Simmons, 2015; Smith III, 2014; Traxler, 2009). Without a school-wide vision, it is difficult to convince faculty that mobile devices have not replaced the need to learn, but instead fostered the need to teach and learn differently (Chen et al., 2015; Simmons, 2015; Traxler, 2009; Whitby, 2014). Students that have grown up in the digital age learn differently and the methods of pedagogy must adapt to meet the gaps that have been created (Chen et al., 2015; Majumdar, 2015; Traxler, 2009; Whitby, 2014). Some of those gaps include how information is processed and a quicker processing speed (Chen et al., 2015; Whitby, 2014). Students that are digital natives are used to accessing large amounts of data on a subject in the span of a few clicks on a technology device (Chen et al., 2015; Whitby, 2014). Applying mobile devices to learning is a huge paradigm shift for all involved in the educational process which can be successfully navigated through the conceptual framework of constructivism.

Another challenge to implementation is making sure that everyone has a digital device. The BYOD concept is beneficial because each student would have a device that they were familiar with, avoiding the need to delay learning with operating instructions (Livingston, 2012; Marcinek, 2014; Nielsen, 2011). Even though students may use their digital devices often, they seem to struggle to understand how to use them productively in the classroom without facilitation from the instructor (Chen et al., 2015; Holland, 2014; Marcinek, 2014; Traxler, 2009). If an educator does not have a grasp on how to successfully implement the curriculum using mobile devices, mobile learning may be seen as too much work (Holland, 2014;

Livingston, 2012; Marcinek, 2014; Simmons, 2015). Proper training in mobile learning implementation is vital (Chen et al., 2015; Simmons, 2015; Traxler, 2009; Whitby, 2014).

Connectivity may be an issue when there are hundreds or thousands of digital devices on campus (Livingston, 2012; Marcinek, 2014). Management from IT departments is vital to the success of one-to-one implementation (Livingston, 2012; Marcinek, 2014). Before a plan is put into place to use devices on campus, the school's infrastructure must be examined in conjunction with implementation (Livingston, 2012; Marcinek, 2014; Traxler, 2009). Items such as the level of connectivity through the Wi-Fi and if the IT department can support a data-centric model, where only certain devices are allowed on the school network, must be determined (Livingston, 2012). Offering apps that are school or teacher specific, email, a cloud storage, and charging stations should be decided upon in the implementation planning stage (CoSN, 2015; Livingston, 2012; Marcinek, 2014; Smith III, 2014). Data security and a digital use policy to protect the institution and users from illegal activities, such as distribution of child pornography or cyber bullying, should be established and then adhered to by all (Livingston, 2012; Traxler, 2009). Implementing mobile learning is much more complex than providing all students with a device or just having everyone BYOD. Getting parents on board is also important for one-to-one plans (Clarke, 2016; Simmons, 2015). A great deal of money goes into providing individual devices for students (Hayes & Greaves, 2013). A good protocol would be to have parents and students sign contracts ensuring proper care and use of a personal student laptop (Heath, 2015).

Suggestions for Smoother Implementation

When an institution is still in the developing stages of one-to-one computer implementation, the good news is that the research offers multiple suggestions, ideas, and designs to get mobile learning started. Chen et al. (2015) and Simmons (2015) found that

establishing a faculty focus group to gather information on how to incorporate mobile technologies in the classroom produced positive attitudes toward implementation. Educators like to be involved in the planning stages (Chen et al., 2015; Clarke, 2016; Grant, 2016; Simmons, 2015; Traxler, 2009). Consulting instructional designers and specialists during the process of deciding on teaching strategies and outlining learning goals offers important pedagogical support for faculty (Chen et al., 2015; Simmons, 2015; Traxler, 2009). If a teacher is not going to utilize the student laptop in their classroom then school-wide implementation will suffer (Simmons, 2015). Offering a professional development course where instructors can collaborate on creating a knowledge base of best practices helps to transfer continued use in the classroom (Chen et al., 2015; Clarke, 2016; Grant, 2016; Holland, 2014; Simmons, 2015). Many teachers are not digital natives and may struggle with the technology themselves. What teacher wants to feel inadequate or flustered in front of their students when teaching? The beauty of the one-to-one initiative is that the goal is for the lessons to be student driven and the teacher to act as a mentor or coach, thus making learning together a more successful pedagogical practice. Providing a variety of training methods that include expert testimonials, technology demonstrations, and best practices offers continual support (Chen et al., 2015; Traxler, 2009).

Items such as online teaching idea repositories and a course on the essentials of mobile learning allows for further collaboration on campus (Chen et al., 2015). With regards to pedagogical mobile app support, Chen et al. (2015) found that the development of the following three tools helped instructors with apps: a mobile checklist that examines features, accessibility, cost, support, and other features when selecting an app; a Mobile Online Tools & Taxonomy Resource, which allows instructors to search for apps that align with learning objectives; and a “Mobile Course Check, in which instructional designers review courses and give faculty a report

that outlines the needed student support documentation and summarizes the course's ease of usability and access on a mobile device" (p. 15). Apps that are already on the laptop make it possible for students without Internet access at home to still work on assignments or practice concepts. Ultimately, the more tools that are offered the smoother the implementation (Bosco, 2015; Clarke, 2016; Heath, 2015). Research has shown that establishing a digital use policy that governs ethical use of digital technology and promoting digital citizenship is imperative to successful implementation (Bosco, 2015; Chen et al., 2015; Livingston, 2012; Majumdar, 2015; Whitby, 2014).

Evaluating Program Success

Evaluation is used to ascertain the impact of learning. Since one-to-one implementation is in its infancy and there are not many educators or learners who have experienced using digital devices for learning, an existing comprehensive framework of evaluation does not exist (Chen et al., 2015; Majumdar, 2015; Traxler, 2009). Growing popularity and ease of use for mobile devices for everything from shopping to entertainment is providing the opportunity for use with learning (Chen et al., 2015; Majumdar, 2015; Marcinek, 2014; Traxler, 2009). Evaluation of mobile learning is necessary and should be continuous to provide for new data (Bosco, 2015; Chen et al., 2015; Clarke, 2016; Majumdar, 2015).

To maximize the value of budget money spent on one-to-one computers, productive ways of evaluation must be developed to ensure there is a lasting valuable impact of mobile learning that can be transferred into the workplace and a global economy (Majumdar, 2015; Traxler, 2009). Mediums such as contribution in online forums and success in completing modules can be used for evaluation (Majumdar, 2015; Traxler, 2009; Whitby, 2014). Monitoring the amount of time, a student spends on the mobile device or within a Learning Management System (LMS)

can be used as an indicator that the mobile learning endeavor is successful (Majumdar, 2015; Menkhoff & Bengtsson, 2012; Traxler, 2009). Asking descriptive questions or assigning text reports that are written on mobile devices and submitted online can present a clear picture of learning mastery (Majumdar, 2015). Tracking actual log data that is built within the mobile learning course can show the number of times a student accesses course material in an effort to evaluate the usefulness of the content and determine what students deem most productive to their learning (Majumdar, 2015). Most importantly, the effect made on student achievement should be viewed if a constructivist framework is to be accomplished.

Suhr, Hernandez, Grimes, and Warschauer (2010) posited that even though one-to-one laptop implementations have been researched, there has been comparatively few studies that have explored the connection between one-to-one devices and student achievement. Current studies have focused more on the outcomes from the development of computer expertise and technical skills rather than student achievement (Storz & Hoffman, 2013). Increases in student achievement in one subject area and technology skills have been reported by some schools after implementing one-to-one computers (“One-to-one computing in public schools,” 2008; Bebell & Kay, 2010). Fleischer (2012) concluded that recent literature found the evidence linking one-to-one device implementations to achievement weak and inconclusive. Hu (2007) ascertained that some schools have canceled their one-to-one programs because evidence of achievement was lacking. This establishes a clear need for research that evaluates a one-to-one device program which focuses specifically on its impact on student achievement.

The challenge of evaluation of one-to-one mobile learning is to collect enough data, so that additional avenues for analysis will ascertain the true worth of using mobile devices and create future ways of delivering mobile learning (Chen et al., 2015; Majumdar, 2015). Including

all the stakeholders involved in a one-to-one implementation is important. Data from students may differ greatly from teachers or administrators and parents. Even though negative claims that one-to-one laptop initiatives do not have a positive impact on student growth (Sauers & McLeod, 2012), adding more research to the implementation of one-to-one school wide initiatives will only help to improve mobile learning.

Review of Methodological Issues

In a review of the literature, one of the main issues that presented itself was the lack of quantitative data regarding the effect a one-to-one computing environment has on academic achievement. Most of the studies reviewed on one-to-one computing initiatives used a mixed method design (Bixler, 2016; Burgad, 2008; Clarke, 2016; Dennis, 2014; Grant, 2016; Harris, 2010; Simmons, 2015; Spanos & Sofos, 2015). A mixed methodology combines quantitative analysis of data regarding participant's perceptions and/or behavior with an in-depth qualitative exploration of attitudes, opinions, and context of the participants (Creswell, 2008). Surveys are used in both qualitative and quantitative research and are a popular data source of mixed method studies (Bixler, 2016; Burgad, 2008; Clarke, 2016; Simmons, 2015; Suhr et al., 2010). A mixed method design allows the researcher to ask closed-ended questions in surveys and questionnaires for quantitative research (Bixler, 2016; Clarke, 2016; Simmons, 2015; Spanos & Sofos, 2015; Stortz & Hoffman, 2013) and open-ended questions in interviews and surveys for qualitative research (Clarke, 2016; Grant, 2016; Harris, 2010; Simmons, 2015; Spanos & Sofos, 2015). There is always an inherent risk to the validity of participant responses anytime a survey or questionnaire is used to gather data. For this reason, the researcher will not be using any surveys or questionnaires and will rely solely on quantitative, non-experimental archival data that is focused on the effect a one-to-one computing environment has on academic achievement.

Lund (2012) indicated that mixed methods research design can increase the validity of inferences and conclusions drawn by using both quantitative and qualitative analyses. Logically by using a mixed methods design Lund's (2012) rationale would have to include that using both quantitative and qualitative analyses would subject the data to double scrutiny for validity of potential confounding variation with regards to population size and the breadth of data gathered. Taking into consideration the chances for statistical error in the data that could occur in a mixed methodology design, a quantitative, non-experimental study focusing on a causal-comparative design and analysis of archival data lends itself as a stronger choice for research to determine the effect a one-to-one environment has on academic achievement.

Denzin and Lincoln (2011) described qualitative research design as "an interpretive, naturalistic approach to the world" (p. 3). Creswell (2013) added that qualitative studies have been conducted to examine social problems. Researchers focusing on the social problems of one-to-one computing environments have studied how the use of technology functions daily in the school (Crooks, 2016), how the efficacy of teachers impacts the usage of technology tools in Algebra I classes (Hile, 2015), and how one-to-one computing affects the learning experiences of students and instructional practices of teachers (Stortz & Hoffman, 2013). Crooks (2016) used class observations, photographs, and interviews with students, teachers, and administrators in a South Los Angeles charter school to conduct the first ever multi-year study of a one-to-one tablet program in California public schools. The qualitative methods Crooks (2016) used were successful to gather data on how technology is used each day and brought to light that the iPads were being used much more freely by administrators for surveillance, discipline, and record keeping than by students and teachers for instructional practices.

Stortz and Hoffman (2013) used interviews of eighth grade students and their teachers to find out how a one-to-one computer initiative impacted student learning experiences, teacher pedagogy changes, classroom management and behavior, the potential for improved communication, and suggestions for professional development needs. Hile (2015) used case study, interviews, and observational data to conduct a qualitative study that showed that technology use was low after seven years of implementation due to a lack of subject specific professional development and resources. Teachers reported that outdated grading policies and negative student behaviors were barriers to successful implementation that were beyond their control (Hile, 2015). Qualitative research design lent itself well to discovering these insights. Since the focus of this study is the effect a one-to-one computing environment has on academic achievement, qualitative design is not the correct fit.

The literature review produced three quantitative studies and only two of those studies focused on one-to-one computers and academic achievement (Heath, 2015; Sprenger, 2010; Yamaguchi et al., 2014), thus showing a gap and a strong need for more quantitative studies. Sprenger (2010) conducted a survey of 90,000 students and 6,000 teachers to find out if teachers exhibit a similar didactic or constructivist style to their teaching at the beginning of a one-to-one implementation and how teaching styles change over time with regards to a continuum from didactic to constructivist because of the use of laptops. The sheer number of study participants included require the use of a quantitative, non-experimental study focusing on a causal-comparative design and analysis of archival data. Some of the research questions might have benefitted from using a qualitative design, but the sample size made this unfeasible.

Sprenger (2010) came the closest by using a quantitative descriptive research design, but does not focus on academic achievement at all. In another study, Yamaguchi et al. (2014) tested

2,000 fifth grade students from Mongolia on math and reading skills and found that the use of computers may have enhanced reading skills while controlling for gender, math scores, and the number of hours spent watching TV, doing homework, and earning money. While this was a quantitative study that focused on academic achievement from one-to-one computer use, the research was focused on one grade level and not a school-wide one-to-one implementation (Yamaguchi et al., 2014). Heath (2015) examined whether a difference existed between one-to-one computing and student achievement in the form of ACT scores. All studies add credence to the need for a quantitative non-experimental study focusing on a causal-comparative design and analysis of archival data that determines the effect a one-to-one computer environment on academic achievement.

Synthesis of Research Findings

Past research regarding one-to-one computer implementation has been conducted at all educational levels from elementary to higher education in the U.S. and other countries and covers a myriad of different sub-topics including use of technology, academic achievement, implementation, professional development, and student and teacher perceptions. Use of technology in educational institutions has increased in the last two decades, but research regarding the impact of one-to-one computer implementation on academic achievement is still limited with gaps in the research (Fleischer, 2012). Bixler (2016) stated that computer technology for students is a popular way for school districts to gain higher achievement in science, technology, engineering, and mathematics (STEM). Hile (2015) discovered that overall usage of technology was low in Algebra 1 classes using one-to-one computers after seven years of implementation.

Academic achievement has always been an important indicator of the educational process and finding pedagogical practices that enhance student academic performance is desirable. Research shows that one-to-one computer initiatives have helped students develop computer and technology skills, but impact on achievement has been harder to determine (Burgad, 2008; Clarke, 2016; Suhr et al. 2010; Yamaguchi et al. 2014). Both positive and negative correlations in academic achievement have been found by researchers during one-to-one computer implementations. In the fifth year of a one-to-one computer implementation, the quantitative findings of Clarke's (2016) study reported a significant correlation with high reading achievement and students using school issued laptops for homework outside of class time, while low reading achievement was significantly correlated with activities such as social networking, game playing, and contributing to online databases. Burgad's (2008) data analysis showed minimal gains to student grades and the amount of time spent on homework, but significant gains in math test scores for students using a laptop during the year of one-to-one implementation.

Standardized test scores have been used frequently as the source of academic achievement data in one-to-one computer studies (Bixler, 2016; Clarke, 2016; Heath, 2015; Suhr et al., 2010; Yamaguchi et al., 2014). Heath (2015) found no statistical difference in SAT composite or subtest scores in English, math, or reading scores two years after one-to-one implementation, but a statistically significant difference in scores in science was shown. MAP (Measure of Academic Progress) test results have shown no difference in the use of one-to-one iPads in middle school mathematics and science classrooms (Bixler, 2016); significant gains in math for junior and senior students and significant negative differences for junior students in reading and senior students in language arts (Burgad, 2008); and high reading achievement for ninth and 10th grade students (Clarke, 2016). Suhr et al. (2010) used the California Standards

Test (CST) in language arts to study students who entered a one-to-one laptop program in fourth grade. Over a 2-year period, the data showed that laptop students outperformed non-laptop students in total language arts scores and two subtest scores of writing strategies and literary response and analysis (Suhr et al., 2010). Reading skills were shown to be enhanced from scores achieved on the National Primary Education Assessment for fifth graders in Mongolia (Yamaguchi et al., 2014).

Successful implementation of a new pedagogy in a school is always a concern of administrators. When the implementation is school-wide, deals with costly technology, and affects all students and staff members, the task can seem overwhelming. Details such as ownership of the computer and who is responsible for damage, loss, or inappropriate use must be determined and understood by all staff, students, and parents (Bosco, 2015). Internet safety and digital citizenship are important skills to be taught as part of a one-to-one implementation (Bosco, 2015; Whitby, 2014). Dedicating a specific tech support person or someone who is responsible for maintaining the actual computer devices will help implementation run smoother and lessen the burden placed on teachers (Bosco, 2015, Heath, 2015, Hayes & Greaves, 2013; Whitby, 2014).

Differences in implementation between schools, grades, teachers, and students have made it difficult to measure the effect an implementation of a one-to-one computer environment has on academic achievement (Bosco, 2015; Clarke, 2016; Whitby, 2014). Hayes and Greaves (2013) surveyed the technology programs in 1,000 U.S. schools and reported that the research shows that effective implementation of one-to-one computer programs can lead to improved student achievement. A survey of 364 administrators from large school districts with one-to-one computer initiatives reported that 78% felt that laptops had a moderate or significant effect on

student achievement (Gillard, 2011; Goodwin, 2011). Bixler (2016) conducted a study of middle school students at three schools in a private school district and found that use of one-to-one computers had no effect on academic achievement in math and science; however, the study did show that the implementation of the one-to-one iPad program did promote the use of constructivist activities by using technology in the classroom.

One of the most important aspects of a successful one-to-one computer implementation is providing teachers and administrators with professional development (Clarke, 2016; Grant, 2016; Hile, 2015; Hoyer, 2011; Simmons, 2015; Storz & Hoffman, 2013; Topper & Lancaster, 2013; Warschauer et al., 2014; Zheng et al., 2016). Hile (2015) found technology use to be low after seven years of a one-to-one implementation in Algebra 1 one classrooms due to a lack of subject specific professional development. Teachers reported that professional development that was ongoing combined with perseverance were necessary components to a successful implementation of one-to-one computers into the classroom (Clarke, 2016, Grant, 2016). A realistic plan with a timeline must be charted out before implementation of one-to-one computers to maximize success (Grant, 2016, Hayes & Greaves, 2013; Simmons, 2015). Effective implementation of one-to-one computer initiatives can produce a significant return on financial investments (Clarke, 2016; Hayes & Greaves, 2013; Simmons, 2015).

Anytime a new pedagogy is implemented, it is prudent to find out the perceptions of the educators responsible for introduction and the students receiving information. Crooks (2016) found that teachers and students were more resistant to the use of one-to-one iPads due to the mandates placed on the implementation by hardware manufacturers, publishers, and administrators. An insufficient network infrastructure and autonomy among student users combined with the professional demands being placed on teachers were found to be the causes of

resistance among students and teachers (Crooks, 2016). Barriers to success expressed by teachers include a lack of technology knowledge and understanding of specific device use, insufficient professional development, and being overwhelmed at the immensity of incorporating one-to-one computers in the classroom (Clarke, 2016; Crooks, 2016; Grant, 2016; Hile, 2015; Simmons, 2015).

Sprenger (2010) discovered that teachers' teaching styles change in all subject areas regardless of the years of experience possessed by the teacher in a one-to-one computer environment. Students report enjoying one-to-one computing devices and find attending school more pleasurable (Bixler, 2016; Burgad, 2008; Clarke, 2016; Spanos & Sofos, 2010; Stortz & Hoffman, 2013). Spanos and Sofos (2010) found that students were bothered by technical problems and that boys were more adaptable to one-to-one learning, but girls showed a greater appreciation for the enhanced learning possibilities computers offered.

Critique of Previous Research

The previous research that has been conducted on one-to-one computer implementations is vast, but strongly deficient in quantitative, non-experimental archival data regarding academic achievement (Fleischer, 2012). The federally mandated Every Student Succeeds Act of 2015, which replaced the No Child Left Behind Act of 2001, has brought academic achievement to the forefront of education requiring States to incorporate three academic indicators into their Accountability Plan to receive federal funding (Klein, 2016). Determining what effect a one-to-one computer environment has on academic achievement is an area of research that is currently lacking and conducting this research study will benefit educational institutions when trying to decide if a one-to-one implementation is the best course of action (Clarke, 2016; Fleischer, 2012; Heath, 2015).

Most of the research that has been conducted on one-to-one computer environments is still focused on the social research aspects of finding out how technology integration affects the perceptions and attitudes of students and teachers (Bixler, 2016; Clarke, 2016; Crooks, 2016; Heath, 2015; Spanos & Sofos, 2015), and how to implement and provide the staff the training they need to be successful in all aspects of a one-to-one initiative (Clarke, 2016; Grant, 2016; Hile, 2015; Simmons, 2015; Zheng et al., 2016). Questions of whether technology is good for education, enjoyable, or just a passing phase are a moot point. Technology is here to stay and is a required 21st century skill for students to be able to function in a global world and be successful. The logical need to research and discover how to begin a one-to-one implementation and keep it growing has been covered and now it is time to begin to research the effect a one-to-one computer environment has on academic achievement.

Summary

The literature has revealed there is much that is still unknown about the impact of one-to-one computer initiatives and a gap exists in quantitative research that shows the effect a one-to-one computer environment has on academic achievement. A study that would be of great benefit would be an exploration of the effect implementation of a one-to-one computing environment has on an entire school's student end-of-year grade point averages and standardized test scores. Based on this literature review, which develops a unique conceptual framework using constructivism, there is sufficient reason for thinking that an investigation examining the effect a one-to-one computing environment has on academic achievement would yield socially significant findings and strengthen the concept of constructivism. The researcher can, therefore, claim that the literature review has provided strong support for pursuing a research project to answer the following research questions:

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

The themes found throughout the literature of digital learning, mobile learning overview, one-to-one computing, the mobile device dilemma, positive impact on learning, challenges for implementation, suggestions for smoother implementation, and evaluating program success combined with future studies would help to further the establishment of one-to-one mobile learning at any education level. A study on the effect a one-to-one computing environment has on academic achievement would further cement the current findings for the success of this new pedagogy. Digital devices are most certainly here to stay. Finding a way to incorporate one-to-one computers into learning is a logical and vital step for education and the ongoing need to show student academic achievement.

Chapter 3: Methodology

Introduction

This quantitative, non-experimental study used a causal-comparative design and analysis of archival data to determine the effect a one-to-one computing environment has on academic achievement means of students in grades six through eight. The researcher explored how the immersion of digital learning through the implementation of one-to-one computers in an entire school impacts academic achievement means. This chapter will present information relevant to the purpose of the study, research questions, hypotheses, research design, target population, sampling method, and related procedures, instrumentation, data collection, operationalization of variables, data analysis procedures, limitations and delimitations of the research design, internal and external validity, expected findings, ethical issues in the study.

The researcher performed an extensive review of the research literature that uncovered a gap in understanding the effect a one-to-one computer environment has on student academic achievement. This quantitative, non-experimental study used a causal-comparative design and analysis of archival data. Student academic achievement was established based on end of year student grade point averages (GPAs) comprised of semester grades in math, English, social studies, and science and the Nevada Smarter Balanced Assessment Consortium (SBAC) results from the summative Math and English Language Arts/Literacy Summative Tests. The results of this study could be used to encourage other schools to implement one-to-one computing environments and will contribute to the existing body of knowledge regarding one-to-one computer environments and student academic achievement.

Purpose of the Study

The purpose of this study was to determine the effect a one-to-one computing environment has on student academic achievement means. One-to-one computer implementation has been widely studied on various subjects and populations. When conducting a search of ProQuest educational research databases, the researcher discovered that very little research has been done on the effect a one-to-one computer environment has on student achievement means. Most studies tend to use a specific subject area, single classroom, the need for teacher development, or student and teacher perceptions for the basis of their research (Bixler, 2016; Clarke, 2016; Grant, 2016; Hile, 2015; Simmons, 2015). This study is focused on bringing to light this underrepresented aspect of one-to-one computing implementation.

Research Questions

The research questions in this study to explore the significant difference in academic achievement mean scores between a one-to-one computer environment and no one-to-one computer implementation included:

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

Hypotheses for GPA Scores

H1₀. There is no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

H1_a. There is a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

Hypotheses for SBAC Scores

H2₀. There is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

H2_a. There is a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

Research Method and Design

The quantitative research methodology used in this study was non-experimental and focused on a causal-comparative design and analysis of archival data. Quantitative research is used to gather data in numerical form such as test scores or final course grades (McLeod, 2017). Research which is quantitative is used to determine ‘precise measurements’ of things (Cooper & Schindler, 2006). Adams and Lawrence (2016) described quantitative research design as a

method to explore a phenomenon in depth and understand prevalence and trends while answering the questions who, what, where, when, and how. Casual-comparative research design or *ex post facto* seeks to find the difference between independent and dependent variables after an event occurred between two different groups (Salkind, 2010). The effect the independent variable of a one-to-one computing environment has on the dependent variable of academic achievement means in the form of end of year grade point averages comprised of semester grades in math, English, social studies, and science, and SBAC scores from Math and English Language Arts/Literacy Summative Tests will be examined to address the research questions. *Ex post facto* was the most logical design to use in determining if the independent variable has an effect on the dependent variable. The quantitative, non-experimental method of using archival research allowed for the study of data that could not be studied through surveys and observations (Adams & Lawrence, 2016). GPAs and SBAC scores are examples of archival research and were used to test the hypotheses. Archival research is defined as the “analysis of existing data or records” (Adams & Lawrence, 2016, p. 113).

McLeod (2017) listed the advantages of quantitative research as being statistically based and thus scientifically objective and rational; useful for testing already constructed theories; rapid analysis due to statistical software; tests hypotheses due to the use of statistical analysis; and research can be replicated. These advantages make *ex post facto* research ideal for exploring the effect one-to-one computing has on student academic achievement. One-to-one computing is a new pedagogical concept but is rooted in constructivism theory that has been used in education for many years. Using causal-comparative analysis in this quantitative, non-experimental study can provide a quick snapshot of the differences between the variables (Salkind, 2010), which would allow for an assessment of intervention needs within an existing one-to-one computing

environment. The study's objective is causal-comparative because the researcher is primarily using archival data and describing the effect the independent variable: a one-to-one computing environment has on the dependent variable: academic achievement in the form of GPA and SBAC mean scores without attempting to “forecast” an event or “explain causes” of a phenomena (Johnson, 2001).

The research shows that quantitative, qualitative, and mixed method studies have been done concerning one-to-one computing (Bixler, 2016; Clarke, 2016; Crooks, 2016; Grant, 2016; Hile, 2015; Spanos & Sofos, 2015). Crooks (2016), Hile (2015), and Stortz and Hoffman (2013) all used the qualitative approach and focused more on the experience of how technology was perceived by students and teachers and if teaching styles or instructional practices were affected by a one-to-one computer implementation. Combining qualitative and quantitative research into a mixed methods approach is overwhelmingly the most popular research design choice. Mixed studies presented standardized test scores in relation to a one-to-one computer initiative, but also looked at qualitative aspects such as technology usage, student and teacher perceptions, and professional development focused on the needs of one-to-one implementation (Bixler, 2016; Clarke, 2016; Dennis, 2014; Grant, 2016; Spanos & Sofos, 2015). Few research studies on one-to-one computer environments use quantitative research design (Sprenger, 2010; Yamaguchi et al., 2014). Sprenger (2010) used a quantitative descriptive design but used the survey aspect to study how educator’s teaching styles change in a one-to-one computing environment. Yamaguchi et al. (2014) conducted quantitative research in Mongolia focusing on literacy and math skills of students in second thru fifth grades by comparing scores from the National Assessment Test (NAT) between students using computers and students with no computers, but

also added in questionnaires to answer questions about the number of hours students watch TV, do homework, hangout with friends, play games, and earn money.

No quantitative, non-experimental studies using a causal-comparative design and analysis were found when using the education databases: Eric (ProQuest), Education Database (ProQuest), Dissertations and Theses Global (ProQuest), Wiley Online Library, and JSTOR to search for research comparing the effect a one-to-one computing environment has on student academic achievement, thus creating a gap in the research. For this reason, a quantitative, non-experimental study with a causal-comparative design and analysis was chosen as the best research method based on the purpose of this study and because it is the most logical method to use when collecting archival data (Adams & Lawrence, 2016; Jones, 2010). *Ex post facto* research design will allow for the use of archival data to analyze the effect the independent variable has on the dependent variable and will allow for a sample size that will help to increase validity and reduce random errors (Salkind, 2010).

Use of *ex post facto* research provided data to answer the research questions of this study and allowed for enhancement to the subject of digital learning in the form of one-to-one computing. Ultimately, the goal of any research is to leave a mark in the continuum of reported data to enlighten the generations down the road. Utilizing quantitative, non-experimental research with a focus on a causal-comparative analysis to report the archival data of this study will add to the augmentation of one-to-one computer implementation in education.

Target Population, Sampling Method, Power Analysis, and Related Procedures

The target population for examining the effect a one-to-one computing environment has on student academic achievement will be approximately 1,344 middle school students enrolled in grades six through eight at Middle School A located in rural Nevada. Middle School A was

selected for participation by the Nevada Department of Education (n.d.) in Nevada Ready 21, a statewide initiative focusing on high standards, developing 21st century skills needed for economic growth, and creating an engaging learning environment. Nevada Ready 21 intends to ensure middle and high school students 24/7 access to a computer by providing a laptop to all the students and teachers at a school. The selected schools rolled out the initial phase of the initiative in the of fall 2016. Middle School A is comprised of grades six through eight with an average yearly enrollment of 660. Approximate yearly enrollment for Middle School A during the study years is 680.

The sampling method used was total population sampling where each student that is enrolled in Middle School A during 2015–2016, the year before one-to-one implementation and 2016–2017, the first year of implementation and 2017–2018, the second year of implementation will be chosen to take part in the study. Total population sample is when an entire population is examined because all participants possess a particular set of characteristics that are uncommon (Lund Research Ltd., 2012). In this study all the students enrolled in Middle School A during 2016–2017 and 2017–2018 will have the uncommon characteristics of participating in a school-wide one-to-one computing environment in middle school. Lund Research Ltd. (2012) surmised that total population sampling is infrequently used due to the time-consuming and challenging nature of trying to sample an entire population with uncommon characteristics. The advantage of total population sampling are deeper insights into the studied phenomenon of an entire population because there is a reduced rate of missing potential insights from members that are not included (Lund Research Ltd., 2012). Total sampling method will give a broader and more accurate representation of the effect a one-to-one computer environment has on academic achievement in an entire school. Utilizing a total sampling method will allow for stronger

research on the middle school population and provide more influential data for other schools considering a school-wide one-to-one implementation.

The total sample population was 1,344 students. By using total population sampling a G Power Analysis was not needed to determine a sample size that would be large enough to provide power and thus reliability and validity to the study. Using the entire population as the sample will provide a smaller confidence interval, which is more desirable because it will increase the precision of the results. Adams and Lawrence (2016) stated that in order to have power, a sample population must be large enough to be representational of the population as a whole. “Power is the ability to find statistically significant results when they exist. Power increases as sample size increases, random error decreases, and the strength of the pattern or relationship increases” (Adams & Lawrence, 2016, p. 282). All students enrolled in Middle School A during the studied school years were included in the study unless opted out, providing a larger sample size and thus a greater level of power.

The target population was notified through passive permission that a study regarding one-to-one computing and academic achievement was being conducted by sending out an explanation of the study on the school websites and letters home. Contact information for parents to be able to opt their student out of the study was provided. Academic data is protected by the Federal Education Rights to Privacy Act (FERPA), which outlines that a student’s individual educational records must be kept confidential and sharing of individual identifiable information must be accompanied by written consent except in certain circumstances (U.S. Department of Education, 2015). One of the exempted circumstances as outlined by the U.S. Department of Education (2015) is when the student’s educational records will be used by an organization conducting a study which predicts tests, administers student aid programs, or enhances instruction on behalf of

the school. The Director of Secondary Curriculum gave the researcher verbal permission to speak with the school principal of Middle School A to request access to the needed data for the study. The school district requested that the findings from this study be presented to the school board in conjunction with data from the Nevada Ready 21 Grant that is funding the school-wide one-to-one computer implementation.

Standardized test scores are reported online by demographic subgroups via the Nevada Department of Education (2017) at nevadareportcard.com. The researcher employed the non-consensual clause outlined in FERPA to gather both the GPA and SBAC statistics needed for this study. The researcher worked with the registrar to access student cumulative files and because of the researcher's access to the student information system as a school counselor, was able to access student transcripts and score reports showing achievement levels on the SBAC tests. This information was transferred into an Excel spreadsheet for organization, to be able to remove student identification, and to run descriptive statistics.

Instrumentation

The instrumentation that was used in this research study includes student end of year grade point averages comprised of an average of the four main core subjects of math, English, social studies, and science, and scores from the Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests. According to the Concordia University, Office of Doctoral Studies (2015), surveys, counts, and test scores are all supportable forms of data collection and should be used to support the research questions of the scientific study. Shih (2007) stated, "test scores served as quantitative measures of learning achievements" (p. 60).

The SBAC assessment was created by educators in response to aligning legislature required state standardized tests to the Common Core State Standards (CCSS) (Smarter Balanced Assessment Consortium, 2017). The SBAC Summative Tests are considered “high stake tests” because the results are used for reporting to secure federal funding. The SBAC is administered each year on or around the 120th day of instruction. To maintain the validity and confidentiality of the test, a high level of security is involved in the administration of the SBAC, where no school district employee has access to the actual test and is not to look at or review the questions. Any breaches in this policy will result in automatic revocation of teacher licensure.

In 2017, SBAC touted over 6,000,000 students in 12 states, the U.S. Virgin Islands, and the Bureau of Indian Education took the end of year summative assessments. Over 47,000 educators have helped develop 33,000 test questions/performance tasks, reviewed test questions, set achievement levels, and developed the Digital Library. Smarter Balanced Assessment Consortium (2016) posited,

The Smarter Balanced system is designed to provide a valid, reliable, and fair measure of student achievement based on the Common Core State Standards⁵ (CCSS). The validity and fairness of the measures of student achievement are influenced by a multitude of factors; central among them are: • a clear definition of the construct—the knowledge, skills, and abilities—that are intended to be measured, • the development of items and tasks that are explicitly designed to assess the construct that is the target of measurement, • delivery of items and tasks that enable students to demonstrate their achievement of the construct • capture and scoring of responses to those items and tasks. (p. 2–3)

Table 1 shows the reported reliability coefficients for both SBAC Math and English Language Arts/Literacy Summative Tests by grade level.

Table 1

Reliability Coefficients for the SBAC

	Grade Level	Reliability Coefficient
Math Summative	6th	.925
	7th	.909
	8th	.918
English Language Arts/Literacy Summative	6th	.908
	7th	.915
	8th	.915

With .908 being the lowest reliability coefficient for both summative tests, the SBAC is a highly reliable instrumentation for all grade levels and will aid in the validity of this study. The SBAC Math and English Language Arts/Literacy Summative Tests consist of two separate assessments. The first test is a computer adaptive test or CAT that will adjust the difficulty of questions based on a right and wrong answer (Smarter Balanced Assessment Consortium, 2018). The CAT is made up of selected-response, constructed response, and technology-enhanced questions (Smarter Balanced Assessment Consortium, 2018). The second test is a performance test or PT consisting of an extended activity designed to test a student's ability to integrate knowledge and critical thinking and problem-solving skills in more than one standard and measures capacities such as depth of understanding, research skills, and complex analysis (Smarter Balanced Assessment Consortium, 2018). The PT is designed to promote college and career readiness and is hand scored by professionally trained readers (Smarter Balanced Assessment Consortium, 2018). Students can take a practice test with sample questions online at the SBAC website.

The research questions for this study were designed to gather the data needed to determine the effect a one-to-one computing environment has on student academic achievement. The best way to gather this archival data was by using quantitative, non-experimental research

with a focus on causal-comparative design and analysis of end of year grade point averages and standardized test scores. Middle School A stores hard copies of report cards and standardized test score reports in individual cumulative files for each student. Final semester grades in math, English, social studies, and science were gathered from student cumulative files, averaged, and calculated using a standard 4.0 grade point average scale. The researcher is a counselor at Middle School A and worked with the registrar to access grade records. GPA statistics were organized by grade level and gender in an excel spreadsheet. Data from the SBAC Math and English Language Arts/Literacy Summative Tests for the 2015–2016 and 2016–2017 school years were gathered from reports provided for school principals and compiled in an excel spreadsheet to make the data easier to work with.

Data Collection

The first step in data collection was to receive verbal permission from the Director of Secondary Curriculum to conduct this study. Second was to contact the principal of Middle School A via email to receive permission to access student cumulative files. Third was to work with the school registrar to transfer the final semester grades in math, English, Social Studies, and science from student cumulative files into an excel spreadsheet. The excel spreadsheet was utilized to average the grades in math, English, Social Studies, and science based on a 4.0 GPA scale. The researcher began with grades from 2015–2016 and continued with 2016–2017. Fourth was to transcribe the achievement level scores for the SBAC Math and English Language Arts/Literacy Summative Test from 2015–2016 and 2016–2017 into the spreadsheet.

For this study, all archival research data was reported in aggregate form and individual student data was not identified. The researcher used univariate analysis to categorize the scores and compile them into histograms to show the frequency, percentages, and cumulative

percentages (Trochim, 2006). Central tendency was then established by computing the mode, median, and mean and variability or how much the scores differed in the sample (Adams & Lawrence, 2016), and was examined by showing the observed minimum and maximum scores, range, and standard deviation. The significance of the correlation was calculated to determine if either of the null hypotheses should be rejected for the alternate hypotheses.

Operationalization of Variables

The independent variable in this study was a one-to-one computing environment and the dependent variable was academic achievement. A one-to-one computing environment is defined by William Penuel, Senior Researcher at SRI's Center for Technology in Learning, as a technology rich educational environment that provides each student and teacher with the use of a portable computer allowing pedagogy to focus on using the laptops to help complete academic tasks and access the Internet ("One-to-one computing in public schools," 2008; Fleischer, 2012). Academic Achievement refers to students' end of year grade point averages in math, English, social studies, and science and students' scores on standardized tests such as the SBAC. Both variables were measured and expressed quantitatively in this *ex post facto* study.

Data Analysis Procedures

Students' end of the year GPAs comprised of semester grades in math, English, social studies, and science were gathered from the year before implementation of the one-to-one computers and compared with the first year of implementation. The researcher put semester grades for first and second semester into an Excel spreadsheet for math, English, social studies, and science. Grades for both semesters of all four classes were added together and averaged to get a grade point average (GPA) that was based on a 4.0 scale where A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0. Descriptive statistics such as mean, median, mode, and standard deviation were

performed. The same procedure was followed for SBAC Math and English Language Arts/Literacy scores. The SBAC is the Legislature-mandated standardized test given to all students in grades 3–8 in Nevada. The four achievement levels scores were assigned a number 1–4: Exceeds = 4, Meets = 3, Approaches = 2, Emergent = 1. Four was high and one was low. Both GPAs and SBAC scores were entered in IBM SPSS Statistics 25 along with the descriptive statistics.

The use of GPAs and SBAC scores in this quantitative, non-experimental study provided archival data that was analyzed using causal-comparative design and utilizing descriptive statistics, which provided summaries about what the data shows without any inferences (Trochim, 2008). The researcher began by using univariate analysis, which involves looking at the distribution, central tendency, and the dispersion of variables one at a time (Trochim, 2008). Distribution determines the frequency of individual values or ranges of values for a variable (Trochim, 2008). The frequency of distributions of the variables was shown by using histograms, bar charts, and box plots. Trochim (2008) described central tendency as the center of a distribution of the values that includes the mean, median, and mode. Along with the mean, median, and mode for each variable, dispersion was established by calculating the range and standard deviation to establish if any deviations from the normal distribution curve occur and whether the deviation is a positive or negative skew (Adams & Lawrence, 2016). Z scores were used to interpret the GPA scores and SBAC achievement levels based on the standard deviation of the distribution and for calculating percentiles.

Upon consulting a statistician, it was determined that z scores alone would not be a stringent enough test to stand up to scrutiny by the greater community of researchers. A one-sample *t-test* was performed using IBM SPSS Statistics 25. The data was checked by the four

assumptions of a one-sample *t-test* for robustness (Laerd, 2015a). The dependent variable, academic achievement, was continuous and not discrete (Laerd, 2015a). All data sets were independent and not paired or identifiable by individual participants and only one dependent variable, academic achievement, at the continuous level is being measured making the a one-sample *t-test* the strongest statistical analysis for this study (Laerd, 2015a). Academic achievement in the form of GPAs and SBAC test scores is numerical and continuous in nature and was based on a normal distribution when calculated in IBM SPSS Statistics 25. The observations of each year of data were independent and by using total population sample were unbiased in nature (Laerd, 2015a). The 2015–2016 year before one-to-one implementation was used as a baseline mean which was then compared to the means from the 2016–2017 first year of implementation and the 2017–2018 second year of implementation. The sample for the mean for 2015–2016 year before implementation was chosen through randomization on IBM SPSS Statistics 25. All data for the dependent variable, academic achievement was checked for outliers by visual inspection of a boxplot (Laerd, 2015a). The four assumptions of a one-sample *t-test* were met and indicated that this statistical analysis was the most robust to test the hypotheses.

Limitations of the Research Design

Many factors can limit or restrict a research study. Quantitative research design does not take place in natural settings and does not allow participants to explain their choices or meanings to questions (Carr, 1994; McLeod, 2017). Confirmation bias might occur, because the researcher is too focused on theory or hypothesis testing and misses observing a phenomenon (McLeod, 2017). According to Concordia University, Doctoral Studies (2015) *Quantitative Writing Guide*, limitations are conditions or circumstances beyond the researcher's control that adversely impact the study but must be reported.

The limitations of this study were many. Time was a factor that affected the validity of the study. The study only covered academic achievement for the year before the one-to-one implementation and the first year of utilizing the Chromebooks school-wide. A study covering additional years of implementation would provide more data and reliability as to the success of the one-to-one computer implementation regarding the research questions. The students were different for each year of the study due to 5th grade students moving up from the elementary level and 8th grade students moving on to the high school. This made pairing GPA and SBAC testing data from one year to the next for participants impossible.

Delimitations of the Research Design

Delimitation refers to the boundaries of the study (Adams & Lawrence, 2016). This study was delimited to sixth through eighth grade students at a middle school located in rural Nevada. Research results were delimited to the students who were enrolled in grades six through eight at Middle School A. GPA and SBAC results were delimited to the 2015–2016 school year without the Chromebooks and the 2016–2017 school year, the first year with the implementation of the Chromebooks and the 2017–2018 school year, the second year with Chromebooks.

Internal Validity

Internal validity describes exactly what type of cogency is related to in the study. As cited in Gall et al. (2007), the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education define validity as the “degree to which evidence and theory support the interpretation of test scores entailed by proposed uses of test” (p. 195). Gall et al. (2007) stated that this “definition highlights the fact that test scores themselves are neither valid nor invalid. Rather, it is interpretations of the scores that are either valid or invalid” (p. 195). “For the study to be high in

internal validity, the manipulated independent variable should be responsible for the changes in the dependent variable, rather than extraneous variables” (Concordia University, Office of Doctoral Studies, 2015, p. 10). This means that the study will be deemed more reliable and valid if the independent variable of a one-to-one computing environment can be shown to be responsible for any difference in means of the dependent variable of student academic achievement.

Items such as selection bias, instrumentation, experimenter effects, and compensation can influence internal validity (Lund Research Ltd., 2012). Selection bias occurs when two groups are being compared and the selection of participants in each group is not equal causing bias (Lund Research Ltd., 2012). By using total population sampling and not splitting the subjects into groups internal validity will be strengthened and selection bias will be avoided.

Instrumentation can be a threat to internal validity when the instrument used to gather data, such as surveys, interviews, or participant observation, changes over time (Lund Research Ltd., 2018).

Instrumentation as a threat was eliminated by using *ex post facto* research design and only reporting archival data such as GPAs and standardized test scores, which leaves no chance for the instrument to change over time. Lund Research Ltd. (2012) explained that experimenter effects come into play when the biases of the experimenter influence the gathering of data through non-verbal cues in interviews or participant observations, or researcher biases being evident in the design of survey questions or interactions with the research participants that end up influencing the directional hypothesis. Causal-comparative research design does not have the researcher actively involved in teaching the students or delivering the standardized tests, so this type of internal validity threat will be reduced. No students were paid to participate thus eliminating a threat of compensation to the internal validity of the research data.

External Validity

Lund Research Ltd. (2012) stated, “In quantitative research, the concept of external validity is important because we want to be able to say that the conclusions we made in our dissertation can be generalized” (External Validity, p. 1). In research results are based upon a sample that is representational of a broader sample (Lund Research Ltd., 2012). Will another school be able use the findings to enhance their implementation of a one-to-one computing environment on a school-wide level? Can the results from this study be added upon to become an integral and driving force for further research and longitudinal studies regarding academic achievement and one-to-one computing? When the answers to these questions is affirmative, external validity is present and will augment the research.

Selection bias, instrumentation, experimenter effects, and compensation can also pose threats to external validity (Lund Research Ltd., 2012). Selection bias will be avoided as a threat to external validity by using total population sampling and including all the students enrolled in Middle School A during the school years data will be collected. The number of enrolled students will be over 1300 which allows for a smaller confidence interval increasing the precise nature of the results and thus the external validity. A smaller confidence interval will allow the results of this study to be generalized more accurately across the broader population of all middle school students participating in a one-to-one computer environment and school-wide one-to-one computer implementations in general. Instrumentation was not a threat to the external validity of this study, because GPAs and the standardized SBAC tests are recognized nation-wide and can be generalized in any educational setting. The high reliability coefficient of the SBAC will strengthen the external validity. Experimenter effects were minimized, because experimenter bias did not affect the results of the independent variable on the dependent variable of the study

allowing generalization by other researchers to produce similar findings. Compensation was not a threat to the external validity of the study and future generalizations because no participants were paid.

Expected Findings

The findings of this study are expected to disprove the Null hypotheses: There is no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did and here is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did. The researcher believed the independent variable of a one-to-one computing environment will show a difference in academic achievement means and be favorable to the implementation within an entire school. Since students are digital natives and technology is such a part of their lives, applying this medium to pedagogy will be an enhancement. Students will be motivated to learn and do assignments. Academic performance will increase GPA and standardized test scores. Students will be more invested in their academic learning and have a desire to reach new levels.

Ethical Issues in the Study

According to the American Psychological Association (APA) (2016), researchers should subscribe to a code of conduct or *Ethics Code* to ensure high standards of conduct, validity of research, and protection of human research subjects. An *Ethics Code* helps to increase the quality of research, which in turn brings respect to a discipline of study. Research on the effect a one-to-one computing environment has on academic achievement is still in its infancy, so violating the

Ethics Code could potentially harm further research and future implementations. The researcher worked with the Concordia University Institutional Review Board (CU IRB) to ensure that the study was ethical since live participants were being used. Once the initial application was filed and permission to conduct research granted by the CU IRB, the researcher followed the outlined protocol and made any adjustments or changes with approval. Any data gathered were kept locked up in the researcher's office. The only copy of data reported by student name was kept in a secure Excel file on the researcher's computer and was not accessible by anyone.

One of the most important elements in research with humans is that a person's rights and dignity are treated with respect (American Psychological Association, 2016). The archival data that was collected was in no way tied to one individual. The data was gathered by the researcher in conjunction with other school personnel but was reported by gender and grade level only. There could be an ethical concern in the statistics if reported with identifying student information. The Director of Secondary Curriculum has told the researcher that all data collected must guarantee respondent anonymity. The researcher accomplished this by assigning numbers rather than names to spreadsheet data.

Summary

For this study quantitative, non-experimental *ex post facto* research design was used. The population for this study was a middle school in rural Nevada that services over 680 students each year in grades six through eight. The research participants were all students enrolled, but not opted out in Middle School A during the year before implementation of the Chromebooks and 2016–2017, the first year of implementation and 2017–2018, the second year of implementation. Ordinal data was collected by gathering GPAs and SBAC scores. GPAs and SBAC level scores were taken from 2015–2016, the year before implementation of the one-to-

one computing initiative, 2016–2017, the first year of implementation, and 2017–2018, the second year of implementation. Data was collected by the researcher, and descriptive statistics will be used to perform a causal-comparative analysis on the data. In Chapter 4 of the study, the researcher will present the data collected for this study. Chapter 5 will contain a discussion of the study, recommendations for future study, and a conclusion.

Chapter 4: Data Analysis and Results

Introduction

In Chapter 4 the data from this quantitative, non-experimental study are presented with a focus on causal-comparative analysis. The purpose of this research was to determine the effect a one-to-one computing environment has on student academic achievement means at a rural middle school campus in rural Nevada. The research focused on determining if a one-to-one computer implementation made any difference in academic achievement means at a middle school where each student and staff member received a Chromebook for their use at school. Academic achievement was represented by taking student's end of semester grade means in math, English, social studies, and science and calculating a GPA on a 4.0 scale and utilizing achievement level score means from the Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests. According to Smarter Balanced Assessment Consortium (2016), the "Smarter Balanced system is designed to provide a valid, reliable, and fair measure of student achievement based on the Common Core State Standards (CCSS)" (p. 3–2). With .908 (as shown in Table 1 in Chapter 3) being the lowest reliability coefficient for both summative tests in Math and English Language Arts/Literacy, the SBAC was a highly reliable instrumentation for all grade levels in this study.

The target population was students in sixth through eighth grade enrolled in a rural middle school in Nevada, which represented the sample population consisting of an average of 681 students per year. The study was delimited to the students enrolled in Middle School A during 2015–2016, the year before implementation, 2016–2017, the first year of the implementation of Chromebooks, and 2017–2018, the second year of Chromebook use. The researcher used total population sampling for 2015–2016, the year before implementation to

establish a baseline mean and a random sample study population of 30% for the first two years of computer implementation.

IBM SPSS Statistics 25 was used to perform the quantitative calculations for this study and to provide an unbiased random sample for the 2016–2017 and 2017–2018 study population of 30% that was compared to the 2015-2016 total population mean. One-sample *t-tests* with a 95% confidence interval and an alpha of .05 were applied as statistical analyses for both GPA and SBAC Math and English Language Arts/Literacy Summative Tests. The one-sample *t-tests* combined with a large sample size provided statistically significant results to compare the year before one-to-one computer implementation with the first year of one-to-one implementation and then the first year of implementation with the second year of one-to-one computer implementation. Within the framework of this study, the limitations that may have impacted the results are the fact that some students were not present in all three years of the study due to promotion to the next grade or changing schools, the lack of data to be able to include Middle School B in the study, and only using core classes to calculate GPAs. The research questions that guided this study to explore the effect a one-to-one computer environment had on academic achievement means were:

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

The underlying hypotheses used to conduct the research for this study were:

Hypotheses for GPA Scores

H1₀. There is no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

H1_a. There is a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

Hypotheses for SBAC Scores

H2₀. There is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

H2_a. There is a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

Archival data was gathered from the student management system and student report cards to test the hypotheses and provide answers to the research questions. Archival research is defined as the “analysis of existing data or records” (Adams & Lawrence, 2016, p. 113). Gathered data was analyzed using central tendency computations, and one-sample *t-tests*. These instruments were deemed as the most suitable for the inquiry of the research questions due to the *ex post*

facto design of this study, the use of archival data, and the large population sample sizes.

Creswell (2013) listed the advantages of quantitative research as being statistically based, less time consuming and expensive, individuals studied are unaware, so they act naturally, and the researcher has no control over the variables only reporting them. This chapter begins with a description of the sample, followed by a summary of the results that includes changes to the original delimitations, and a detailed analysis that addresses the two research questions that guided this study.

Description of the Sample

The actual target population for this study were students enrolled in Middle School A during the 2015–2016 ($n = 659$), 2016–2017 ($n = 689$), and 2017–2018 ($n = 699$) school years. The study years were respectively 2015–2016, the year before the one-to-one computer implementation, 2016–2017, the first year of implementation of Chromebooks, and 2016–2017, the second year of computer implementation to each student and staff member. The original study proposal included the students enrolled at Middle School B, the other middle school in rural Nevada that had been awarded the Nevada Ready 21 Grant. During the years of the study there was a change in student management systems along with a crash of four system servers resulting in a loss of electronic data.

Teachers at Middle School B did not keep hard copies of their grades, whereas the teachers at Middle School A did. The researcher used the teacher's hard copies of grades and final report cards in the student cumulative files together for all students enrolled in the 2015–2016 school year at Middle School A. Semester grades at Middle School B could have been accessed in the form of report cards filed in the student cumulative folders, but any student who moved would not have had an accessible file. Using data from Middle School B would have

affected the internal validity and reliability of the study and not been accurate for the total population sampling method that was used. The researcher submitted a modification to the IRB and Middle School B was removed from the study. Middle School A then became the sole school in the study and the source for the actual participant sample.

In the 2015–2016 school year, 682 students were enrolled at Middle School A, 711 students were enrolled during 2016–2017, and 714 during the 2017–2018 school year. Passive permission was used to notify the target population that a study regarding one-to-one computing and academic achievement was being conducted by sending out an explanation of the study on the school websites and letters home offering contact information for parents to be able to opt their student out of the study. Academic data is protected by the Federal Education Rights to Privacy Act (FERPA), which outlines that a student’s individual educational records must be kept confidential and sharing of individual identifiable information must be accompanied by written consent except in certain circumstances (U.S. Department of Education, 2015). One of the exempted circumstances as outlined by the U.S. Department of Education (2015) is when the student’s educational records will be used by an organization conducting a study which predicts tests, administers student aid programs, or enhances instruction on behalf of the school. Standardized test scores are reported online by demographic subgroups via the Nevada Department of Education (2017) at nevadareportcard.com. The researcher employed the non-consensual clause outlined in FERPA to be able to gather both the GPA and SBAC statistics needed for this study.

Some students were removed from the total population sample due to parent refusal to have their student’s data included, enrollment in the special education self-contained classroom, and/or because the student had not been awarded a semester grade as a result of partial year

enrollment. Using these guidelines, 23 students from 2015–2016 were removed resulting in 97% of the target population being sampled ($n = 659$), 26 students from 2016–2017 were removed resulting in 96% of the target population being sampled ($n = 685$), and 15 students were removed from 2017–2018 resulting in 98% of the target population being sampled ($n = 699$). The actual participant sample for all years reported in the study is displayed in Table 2 by frequency of race and gender. Race and gender are demographics that are reported by the parent upon enrollment of the student. These figures were gathered from the student reporting system Infinite Campus and are included as profile information to enhance the understanding of who participated in the study.

Table 2

Demographic Characteristics of Student Participants by Year and Represented by Frequency and Percentage

	2015–2016		2016–2017		2017–2018	
	Frequency	%	Frequency	%	Frequency	%
<i>Gender</i>						
Male	353	54	359	52	352	50
Female	318	46	326	48	347	50
<i>Ethnicity</i>						
Asian	3	0.5	5	0.7	6	0.9
Black	3	0.5	2	0.3	4	0.6
Caucasian	576	87.0	595	87.0	604	86.4
Hispanic	53	8.0	63	9.1	70	10.0
American	12	2.0	9	1.3	8	1.1
Indian						
Mixed	12	2.0	11	1.6	7	1.0

Male participants represented the majority of students with 54% for 2015–2016, 52% for 2016–2017, and 50% for 2017–2018. The percentages of males decreased by 2% each consecutive year, while female students increased by 2% each year. Caucasian ethnicity made up the majority of participants for all three study years, with Hispanic being the second highest

ethnicity represented at 8% for 2015–2016, 9.1% for 2016–2017, and 10.0% for 2017–2018.

Asian, Black, American Indian, and Mixed ethnicity study participants were represented as less than 50% of the Hispanic population ($n = 30$) for 2015–2016, ($n = 27$) for 2016–2017, and ($n = 25$) for 2017–2018.

Summary of the Results

This casual-comparative research design sought to determine the effect a one-to-one computing environment had on student academic achievement in the form of GPA and SBAC Math and English Language Arts Summative Test score means. In an effort to stay true to the purpose of the study and present an accurate depiction of the effect a one-to-one computing environment had on academic achievement, total population sampling was used to represent a precise picture of a school-wide one-to-one computer implementation in the gathering of GPA and SBAC data from Middle School A to establish the baseline mean and subsequent mean from two years of one-to-one computer implementation. In this section, validity and reliability will be examined, limitations will be declared, and findings associated with GPA and SBAC Math and English Language Arts Summative Test scores will be examined.

Validity. Internal validity can be influenced by selection bias (Lund Research Ltd., 2012). Selection bias was avoided, and internal validity strengthened by using total population sampling which included all students enrolled in the year before one-to-one computer implementation to establish a baseline mean. The baseline means for 2015–2016 GPA and SBAC Math and English Language Arts Summative scores were calculated using central tendency computations in both Excel and IBM SPSS 25. Selection bias was avoided by randomly selecting a 30% study population for 2016–2017 and 2017–2018, the two years of implementation, providing a more accurate depiction of the effect a one-to-one computer

implementation had on academic achievement (LaMorfe, 2016). IBM SPSS 25 was used to randomly figure the 30% sample population for GPA and SBAC Math and English Language Arts/Literacy means for both years of one-to-one computer implementation. By using the entire student population enrolled during each year of the study, random error is minimal if non-existent because there is a greater likelihood that the study sample is representational of the total population of all middle school students involved in a one-to-one computer implementation (Adams & Lawrence, 2015; LaMorfe, 2016; Laerd, 2015a). The original study proposal was delimited to students enrolled at two middle schools that were awarded the Nevada 21 Grant in Nevada. Once it was discovered that reliable records of student GPAs and SBAC scores for Middle School B did not exist, Middle School B was eliminated from the study to strengthen internal validity. There was no way to ensure that all student's academic data for the years of study could have been accessed and included. This would have affected the sample in any case, but especially the use of total population sampling in this study.

Due to the additional year that was added during the data collection period, academic grades and SBAC scores that had been archived for the 2017–2018 school year became available, so the second year of computer implementation at Middle School A was added to the study. Adding an additional year of data to the study strengthened the validity of the results in relation to total population sampling and provided credence to the longitudinal aspect of this study. A longitudinal study using total population sampling is desirable to provide valuable data to other schools making decisions on school-wide one-to-one implementations (Warschauer & Zheng, 2016).

Reliability. Instrumentation as a threat was eliminated by using *ex post facto* research design and only reporting archival data such as GPAs and standardized test scores in the form of

the Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Tests. Grade Point Averages (GPAs) were calculated on a 4.0 scale as reported in Table 3. GPAs on a 4.0 scale are a widely acceptable and reliable indicator of student academic performance (Bacon & Bean, 2006; Clark, 1964; Millet, 2018;).

Table 3

4.0 GPA Grade Scale

Grade	GPA
A	4.00
B	3.00
C	2.00
D	1.00
F	0.00

Both instruments used are widely accepted in education and the SBAC tests possess a high degree of correlation with a reliability coefficient range of .908 to .925 shown in Table 1. A high degree of correlation leaves no chance for the instrument to change over time (Smarter Balanced Assessment Consortium, 2016) and strengthens reliability. The Smarter Balanced Assessment Consortium reports scores from Math and English Language Arts/Literacy Tests in two ways: scaled scores, and achievement levels. Achievement levels are individual student SBAC scores that correlate with the scaled scores as shown in Table 4. Scaled scores are represented by a range of scores depending upon grade and subject. Achievement levels in Nevada are divided into four categories: Emergent, Approaching, Meets, and Exceeds and are the same for both SBAC Math and English Language Arts/Literacy Tests for all three grades. Scaled scores were not readily available for all three years of the study due to a server crash by the company that administered the SBAC tests nationwide. Several states sued this company and

student's scaled scores were not released due to the lawsuit. Achievement levels were released to the schools for use to meet federal mandates with regards to standardized testing. Achievement levels reported on the Math and English Language Arts/Literacy SBAC were used to perform all calculations for this study.

Table 4

SBAC Math and English Language Arts/Literacy Achievement Levels and Correlating Scaled Scores

SBAC Test	Level 1 Emergent	Level 2 Approaching	Level 3 Meets	Level 4 Exceeds
6th Math	<2473	2473–2551	2552–2609	>2609
7th Math	<2484	2484–2566	2567–2634	>2634
8th Math	<2504	2504–2585	2586–2652	>2652
6th ELA/Lit.	<2457	2457–2530	2531–2617	>2617
7th ELA/Lit.	<2479	2479–2551	2552–2648	>2648
8th ELA/Lit.	<2487	2487–2566	2567–2667	>2667

Level 1 or emergent is when a student is struggling in math and English Language Arts/Literacy and is well below grade level. Many students with learning disabilities are in this category. Level 2 or approaching are the students that are considered bubble kids or just below grade level. Level 3 or meets are the students that are at grade level in math and English Language Arts/Literacy. Level 4 or exceeds are the students that demonstrate an exceptionally

higher than normal performance in math and English Language Arts/Literacy and would be considered at the top of their class.

Limitations. Several unforeseen limitations were encountered as the study progressed. First, was the lack of archival data from Middle School B, which was combated by eliminating the school from the study. Second, in the original proposal z-scores were to be the statistical instrument used to determine significance of GPAs and SBAC Math and English Language Arts/Literacy scores. In consultation with a statistician, the researcher determined that z-scores were not a stringent enough analysis to lend credence to the validity and reliability of the study and would not hold up to future scrutiny in the research community. This study was designed to focus on the gap that exists in the research on school-wide implementations. To keep the viability of the study, each study year was used as an independent sample and GPAs and SBAC scores were amassed. The mean of the year before implementation was used as a baseline and a random sample of 30% from each ensuing year was used to compare the descriptive statistics and test the null hypotheses by one-sample *t-test* from both research questions by employing a one-sample *t-test*. A one-sample *t-test* was used to compare the baseline mean from 2015–2016 with the 30% sample population with 2016–2017, the first year of one-to-one computer implementation for both GPA and SBAC. The one-sample *t-test* was then repeated using the 2015–2016 baseline mean with the 30% sample population from 2017–2018, the second year of implementation. Using the one-sample *t-test* in a longitudinal study strengthens the viability of the study (Laerd, 2015b; Warschauer & Zheng, 2016).

Findings associated with GPA. To answer research question 1, semester grades were collected from teacher grade books, report cards in student cumulative files, and the student

management system, Infinite Campus, and entered into an Excel spreadsheet. Student names were only entered on the original spreadsheet controlled by the researcher to maintain anonymity and adhere to FERPA (Federal Education Rights to Privacy Act) standards. Students removed from the study due to parental refusal to participate and receiving passing grades instead of letter grades due to enrollment in the special education self-contained classroom were only kept on the original Excel file and removed from all other analyses. Scores were entered in Excel by using the student's first and second semester grades in math, English, science, and social studies. These four classes are the core classes that are required for all three grade levels. Semester grades were then averaged into an overall GPA based on a 4.0 grade scale found in Table 3 where A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0. Results were compiled and studied in aggregate. Central tendency data was calculated and used to create histograms which showed that the GPA data collected to answer research question 1 were negatively skewed, as shown in Figures 1, 2, and 3 by the study year.

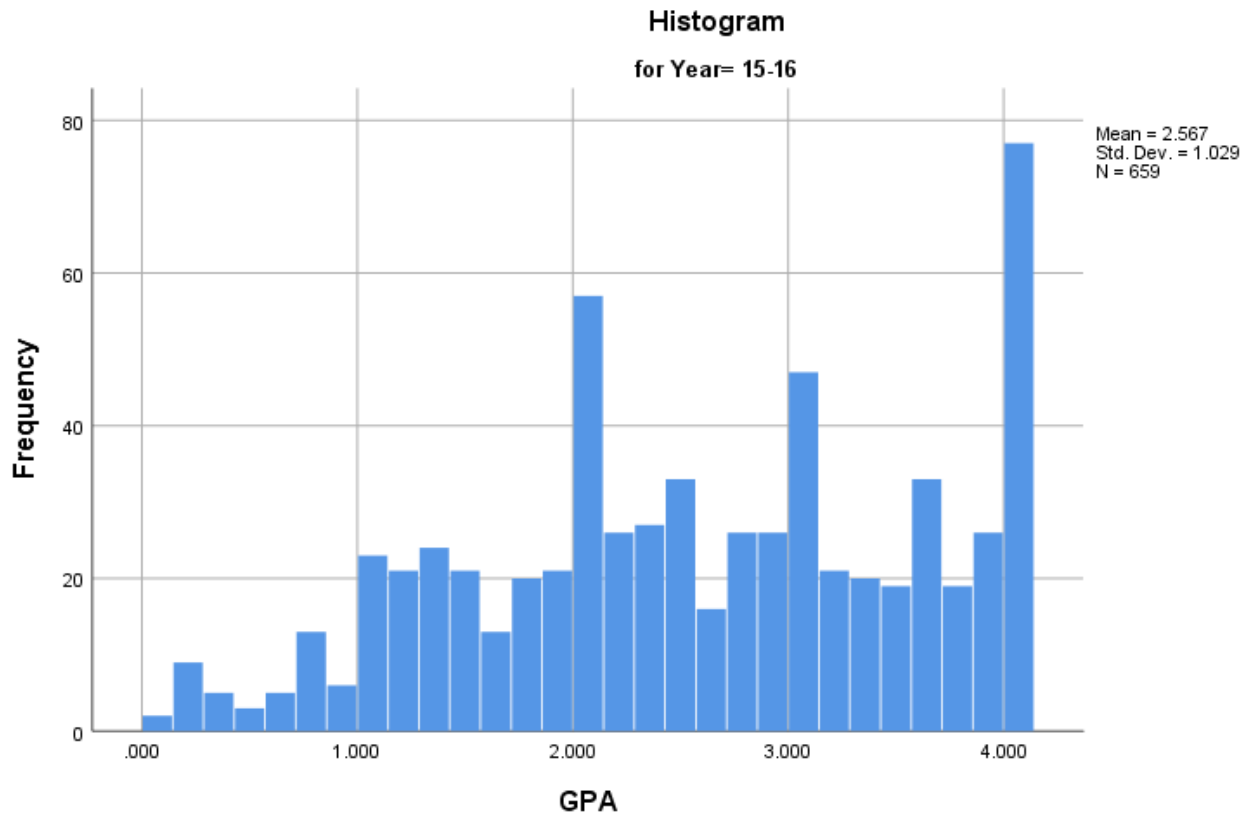


Figure 1. Histogram of GPAs 2015—2016, year before implementation

The mean for GPAs from the year before one-to-one implementation was 2.567. This mean is depictive of the total population sample of students enrolled in the 2015–2016 school year. The distribution for the frequency of scores showed a negative skew with the highest frequency of GPA scores represented by 4.00 or As, the second highest as 2.00 or Cs, and the third highest as 3.00 or Bs.

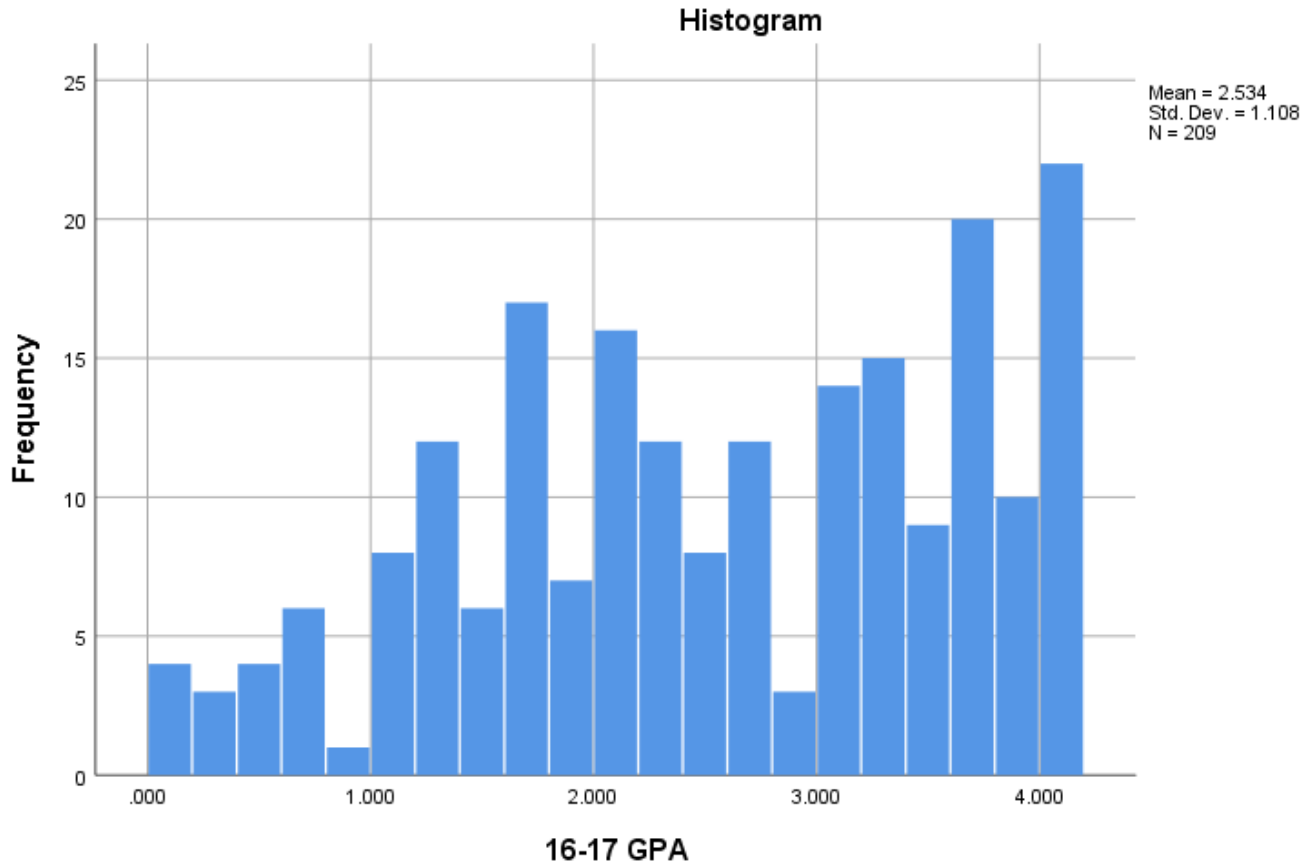


Figure 2. Histogram of GPAs 2016–2017, first year of implementation

The mean for GPAs from the first year of one-to-one implementation $M = 2.534$, which is lower than the $M = 2.567$ mean from 2015–2016. The distribution for the frequency of scores showed a negative skew with the highest frequency of GPA scores represented by 4.00 or As, the second highest as high Bs, and the third highest being represented as a tie between high Ds and high Bs. There are not as many low scores per grade in 2015–2016 as there are in 2016–2017 and the frequency of the failing grades below 1.00 or D to zero are lower in 2016–2017 than 2015–2016.

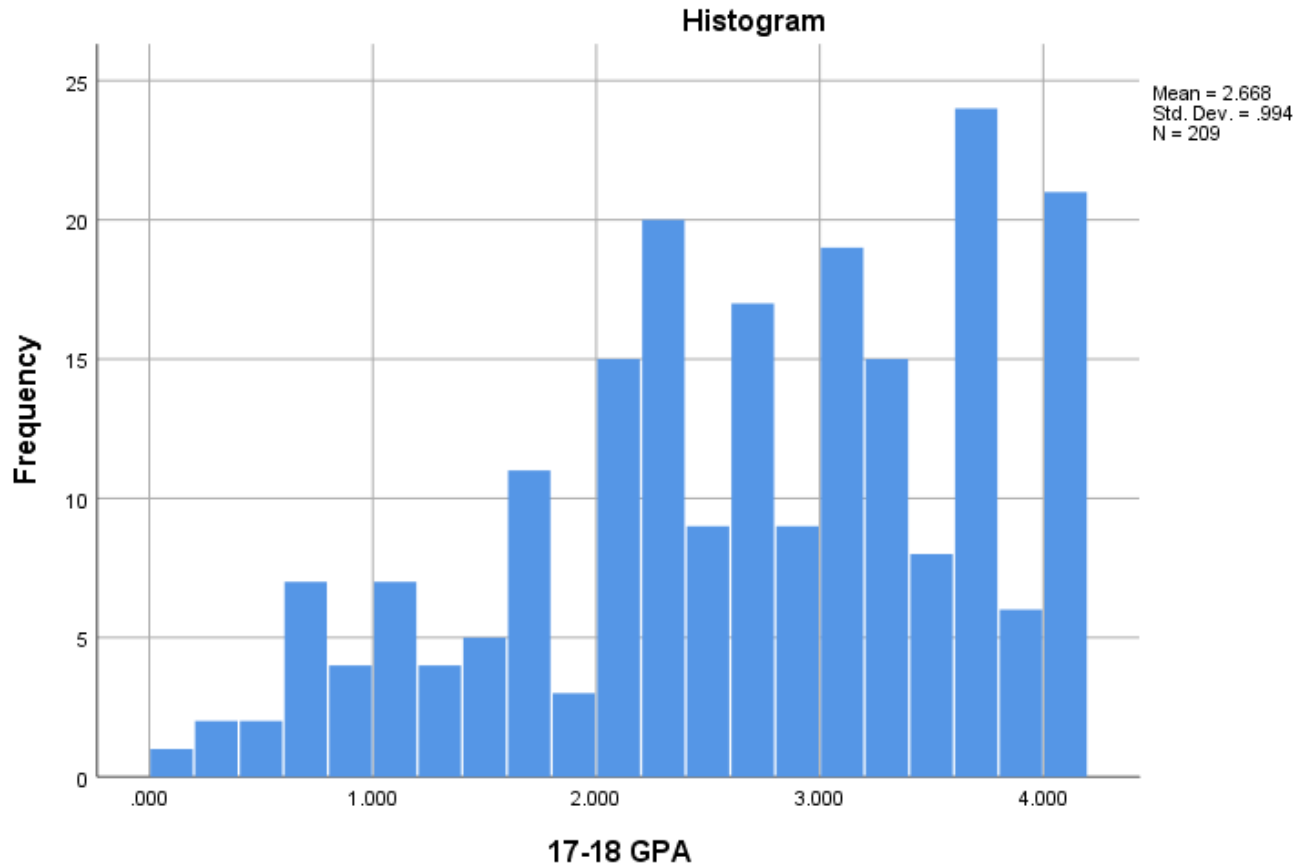


Figure 3. Histogram of GPAs 2017–2018, second year of implementation

The mean for GPAs from the second year of one-to-one implementation was $M = 2.668$, which is higher than the $M = 2.567$ from 2015–2016. The distribution for the frequency of scores showed a negative skew with the highest frequency of GPA scores represented by high Bs, the second highest 4.00 or As, and the third highest as low Cs. The frequency of GPAs between 2.00 or Cs and 4.00 or As is generally higher in frequency across all years.

Z-scores were used to check the distribution of GPA scores for the study years. In the original proposal the researcher was only to look at the z-scores. After gathering the data, it was discovered that while this would indicate how many GPA scores fit into each percentile, it would not provide a stringent enough test to accept or reject the hypotheses. For this reason, a one-sample *t-test* was conducted for GPA scores. The baseline mean from 2015–2016, the year

before implementation was compared with the mean from 2016–2017, the first year of implementation and again with the mean from 2017–2018, the second year of implementation. According to Laerd (2015a) a one-sample t test is the statistical analysis most frequently used to determine if a statistical difference exists between the mean of a population and the mean of a sample population to determine if the sample is representative of the population. For the purpose of looking at each academic year of this study as a whole to minimize random error, each study year is being used as an unrelated group even though some of the same students could be in the randomly selected sample groups. All data sets are independent and are not paired or identifiable by individual participants and only one dependent variable at the continuous level is being measured making the a one-sample t -test the strongest statistical analysis for this study (Laerd, 2015a).

Student GPA data were checked using Levene's Test for Equality of Variances and it was discovered that equal variances were assumed due to the assumption of homogeneity of variances not being violated. Boxplots were run to search for outliers in the data as show in Figures 4, 5, and 6.

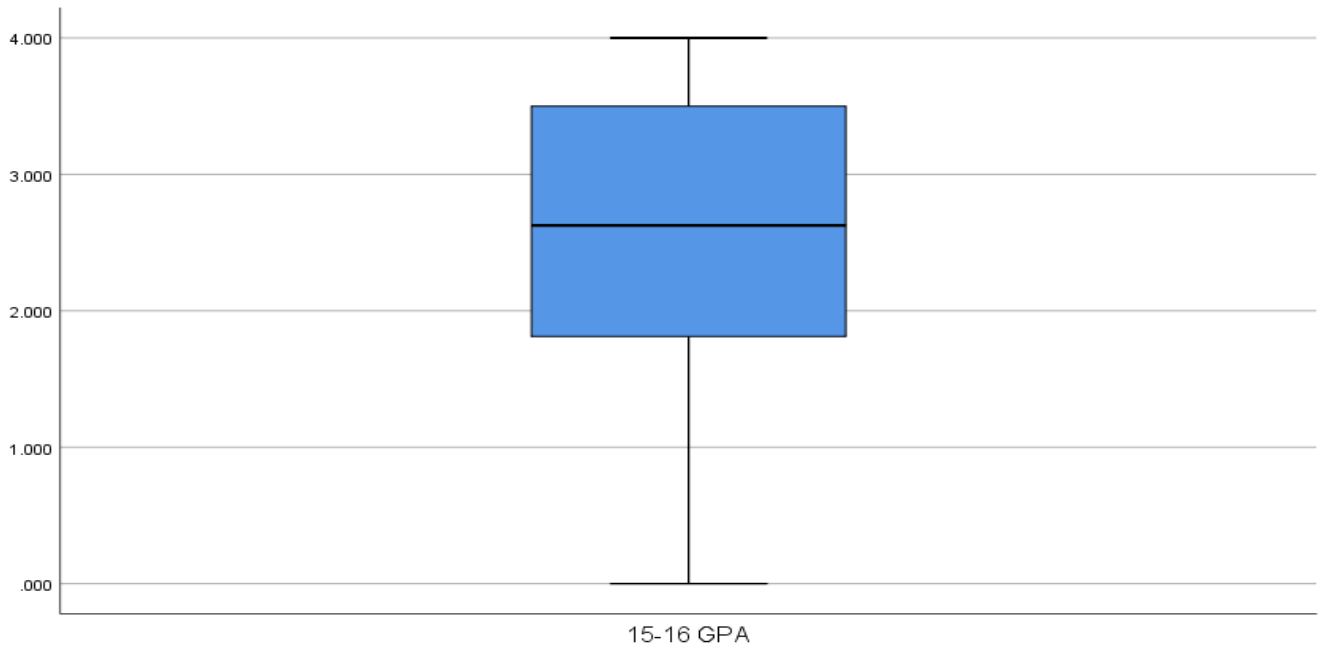


Figure 4. Boxplot for 2015–2016 GPA

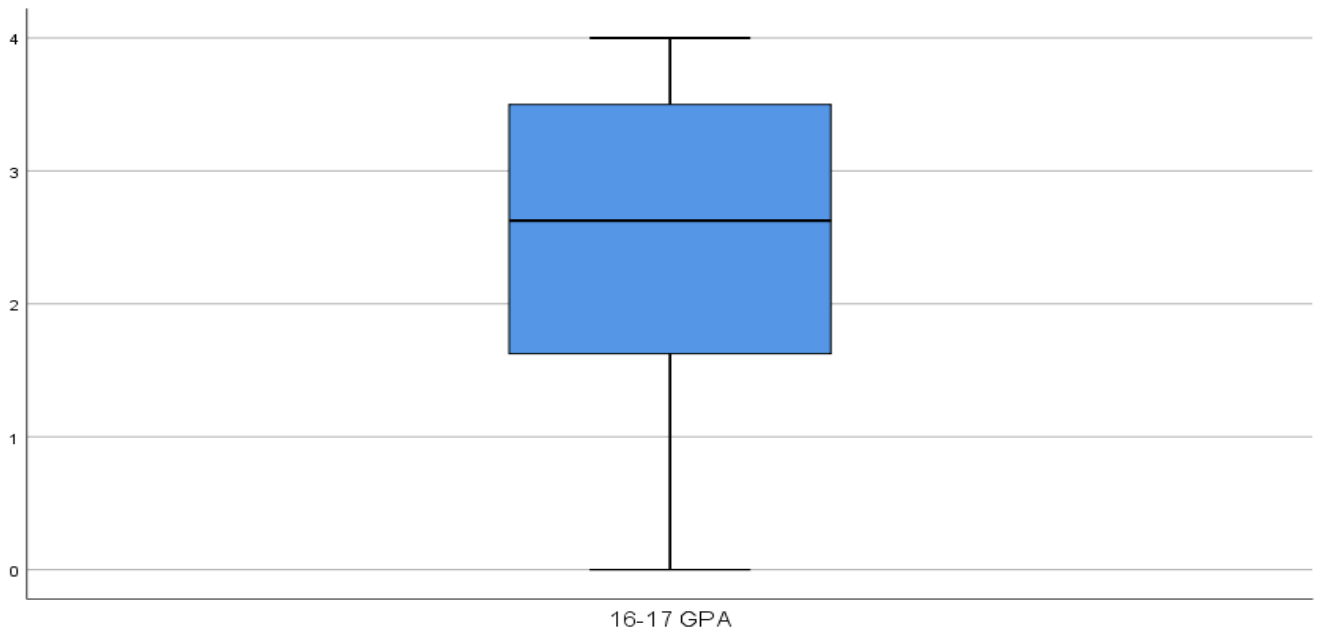


Figure 5. Boxplot for 2016–2017GPA

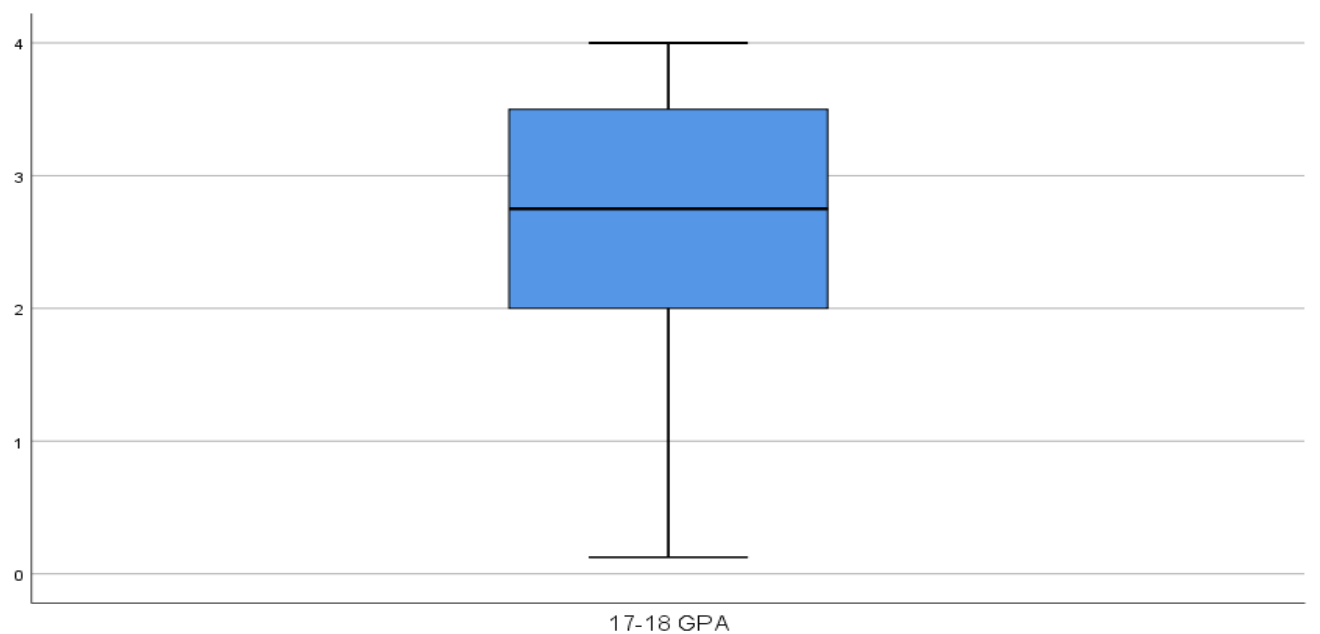


Figure 6. Boxplot for 2017–2018 GPA

There were no outliers in the data, as assessed by visual inspection of the produced boxplots by searching for values greater than 1.5 box-lengths from the edge of the box. Normal distribution was then established with a Shapiro-Wilk's test. A one-sample t test was run to

compare the year before implementation with the first year of implementation and a second one-sample *t-test* was conducted between the year before implementation and the second year of implementation. The fact that the study design used total population sampling to get an accurate look at a school-wide one-to-one computer implementation, led to reporting academic achievement by year only and not grade level or gender. While the level comparisons of gender and grade are interesting to note, realistically a school would never provide computers to just one gender. They might choose a grade level to begin with, but when looking at an entire school implementation even that would not be a plausible outcome.

Findings associated with SBAC testing. To address research question 2, SBAC scores were taken from the reports provided by the Nevada State Department of Education in math and English Language Arts/Literacy and entered in an Excel spreadsheet. The SBAC scores are reported by achievement levels based upon proficiency in math or English Language Arts/Literacy. The Exceeds (4) and Meets (3) levels indicate being at or above the proffered standard in math and English Language Arts/Literacy and the Approaches (2) and Emergent (1) levels indicate being below the set standard or evidence of a struggling student. The data for math and English Language Arts/Literacy was analyzed separately and will be presented in two subsections.

Math SBAC. Table 5 showed the frequency of achievement levels by grade on the math portion of the SBAC for all enrolled students that participated during the study years.

Table 5

Achievement Levels of Students on the Math SBAC Represented by Year, Frequency and Percentage

<i>Math SBAC</i>	2015–2016		2016–2017		2017–2018	
	Frequency	%	Frequency	%	Frequency	%
<i>6th Grade</i>						
N	222		237		214	
Exceeds (4)	26	12	11	4	33	15
Meets (3)	54	24	42	18	51	24
Approaches (2)	84	38	114	48	71	33
Emergent (1)	58	26	70	30	59	26
<i>7th Grade</i>						
N	200		216		226	
Exceeds (4)	8	4	11	5	10	4
Meets (3)	34	17	42	19	40	18
Approaches (2)	94	47	92	43	109	48
Emergent (1)	64	32	71	33	67	30
<i>8th Grade</i>						
N	206		213		205	
Exceeds (4)	21	11	13	6	9	4
Meets (3)	36	18	29	14	39	19
Approaches (2)	74	37	82	38	90	44
Emergent (1)	75	38	89	42	67	33

The collected data were entered in Excel and IBM SPSS Statistics 25 for analysis and to look for significant statistical differences. Randomization was performed on the total population samples from 2016–2017, the first year of implementation and 2017–2018, the second year of implementation to find a 30% study sample to be compared to the baseline population from 2015–2016, the year before implementation. Central tendency data was calculated and used to create histograms of SBAC math scores, as shown in Figures 7, 8, and 9, which showed that the data collected to answer research question 2 were positively skewed for all three years of the study.

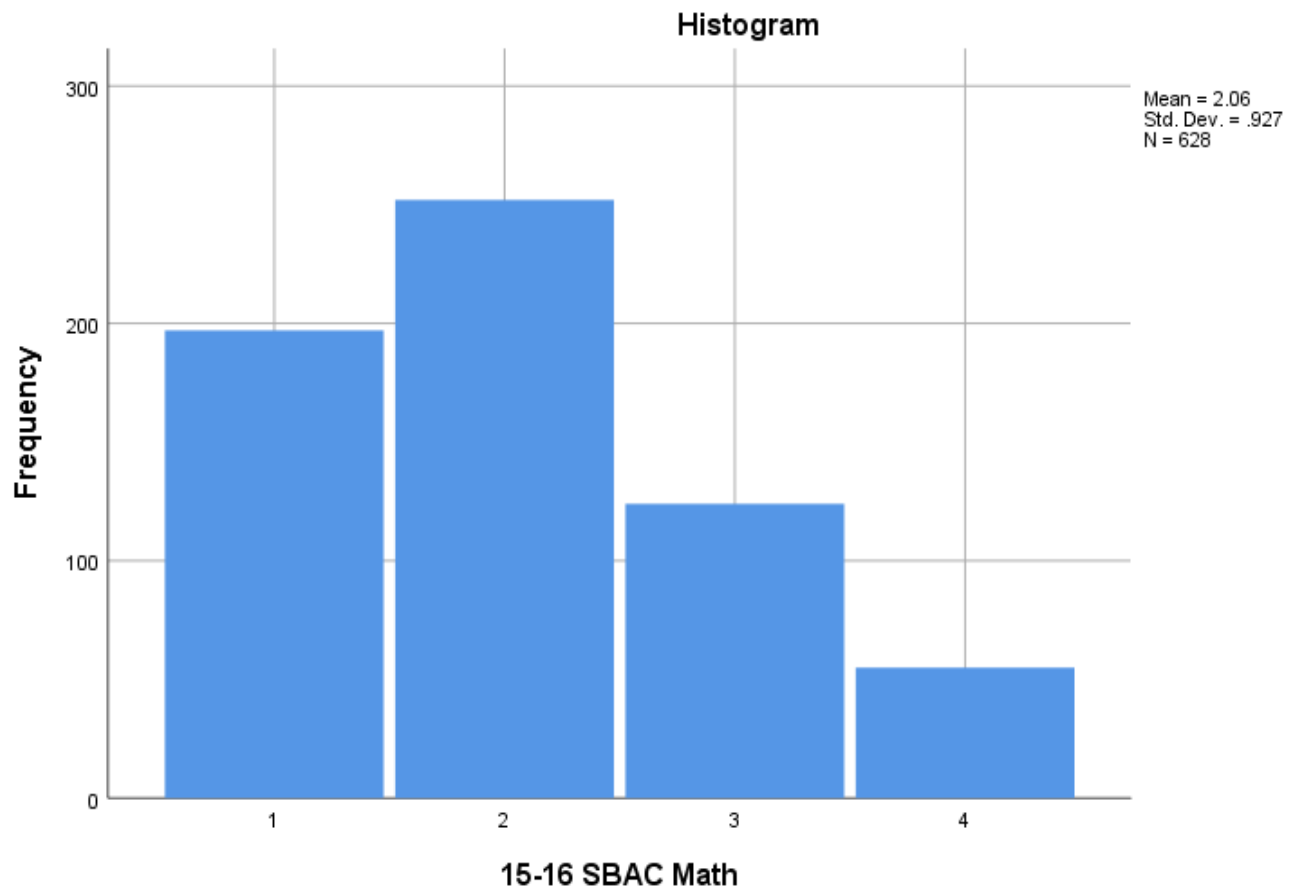


Figure 7. Histogram showing frequency of math SBAC achievement scores for 2015–2016, year before implementation.

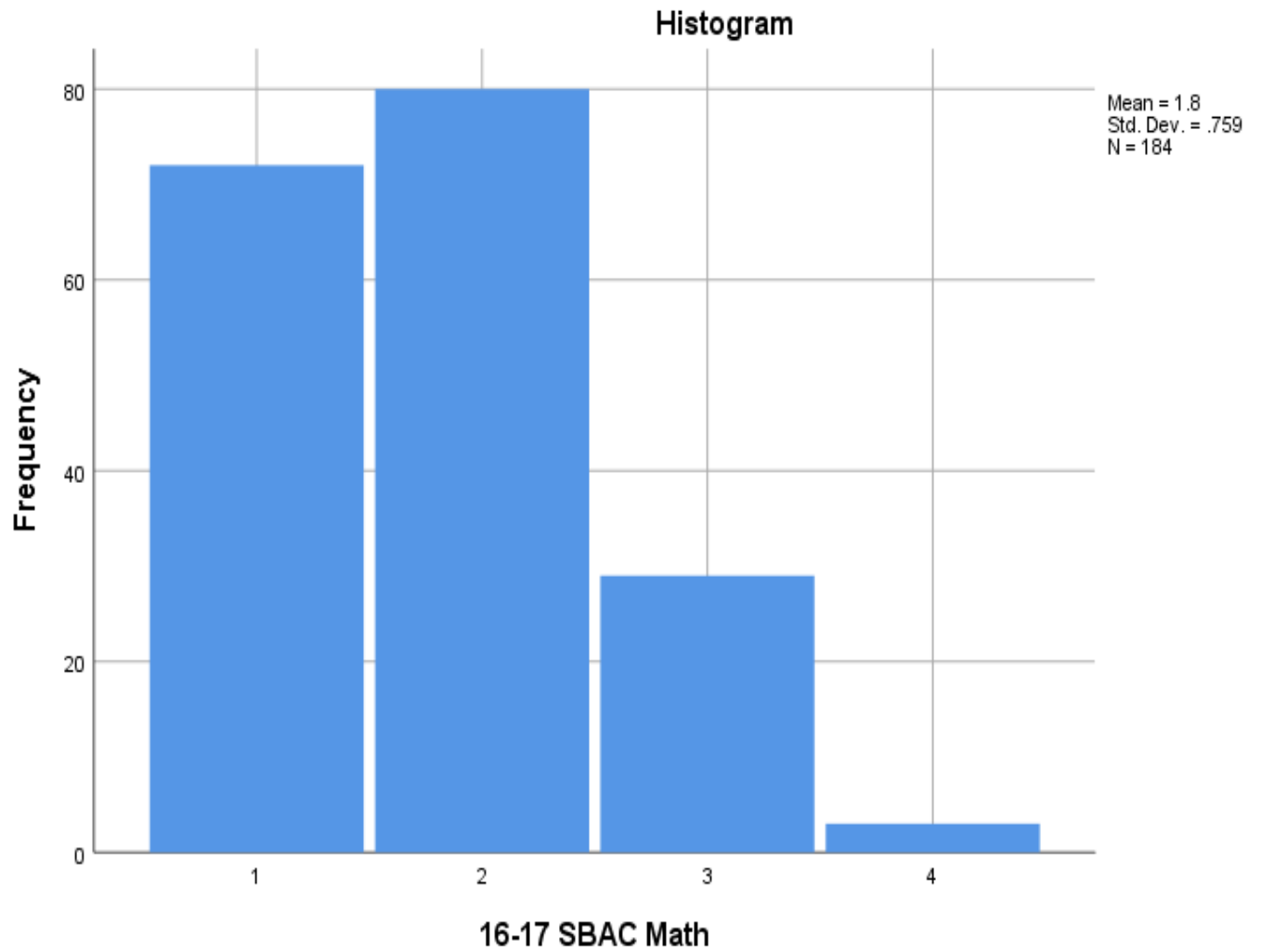


Figure 8. Histogram showing frequency of math SBAC achievement scores for 2016–2017, first year of implementation.

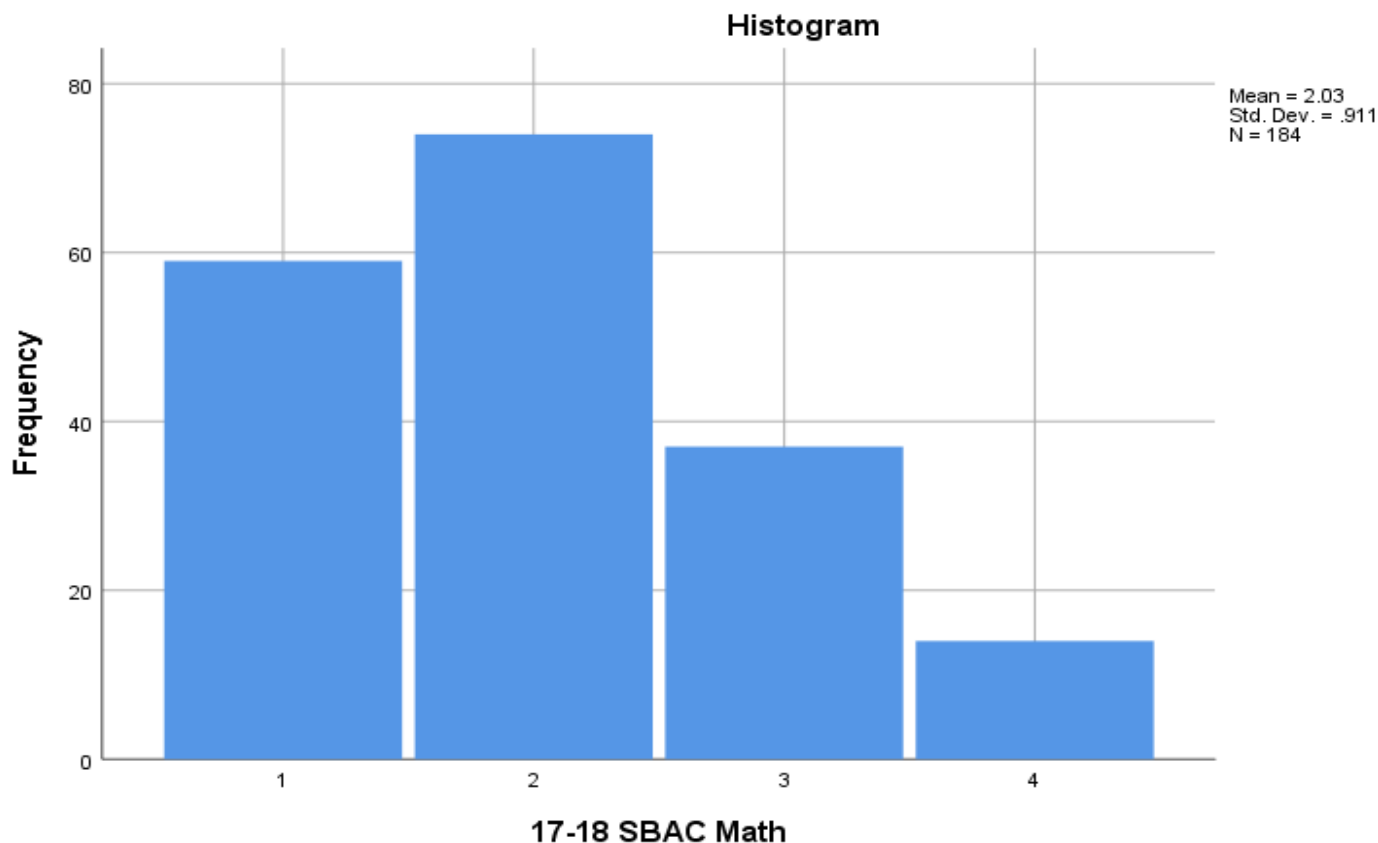


Figure 9. Histogram showing frequency of math SBAC achievement scores for 2017–2018, second year of implementation.

The mean for the year before implementation was $M = 2.06$, $M = 1.8$ for the first year of implementation, and $M = 2.03$ for the second year of implementation. Approaches (2) was the most frequent achievement level met with Emergent (1) second, Meets (3) third, and Exceeds (4) the fourth most frequent for all three years. From the histograms it is obvious to see that Meets (3) and Exceeds (4) achievement levels for the first year of implementation are considerably lower in frequency from the Approaching (2) and Emergent (1) levels as compared to the other two years. The histograms indicated that the majority of students did not meet the set standard in math, indicating that more students were struggling in math than succeeding.

A one-sample *t* test was conducted using Excel SPSS 25 for SBAC math scores. Means were calculated for the year before implementation and the first year of implementation to find the hypothesized difference in means, if any. The mean for the year before implementation was higher $M = 2.06$ than the $M = 1.8$ for the first year of implementation for scores on the Math SBAC. The same process was repeated between the year before implementation and the second year of implementation. The mean for the year before implementation was higher $M = 2.06$ than the $M = 2.03$ for the second year of implementation.

English Language Arts/Literacy SBAC. Table 6 showed the frequency of achievement levels by grade on the English Language Arts/Literacy portion of the SBAC for all enrolled students that participated during the study years.

Table 6

Achievement Level Scores of Students on the English Language Arts/Literacy SBAC Represented by Year, Frequency and Percentage

<i>ELA/Lit. SBAC</i>	2015–2016 Frequency	%	2016–2017 Frequency	%	2016–2017 Frequency	%
<i>6th Grade</i>						
<i>N</i>	222		237		216	
Exceeds	33	15	8	3	24	11
Meets	92	41	66	28	74	34
Approaches	62	28	107	45	59	27
Emergent	35	16	56	24	59	27
<i>7th Grade</i>						
<i>N</i>	200		216		226	
Exceeds	5	3	3	2	7	3
Meets	77	39	70	32	64	28
Approaches	68	34	88	41	101	45
Emergent	50	25	55	25	54	24
<i>8th Grade</i>						
<i>N</i>	208		213		205	
Exceeds	15	7	14	7	2	1
Meets	79	38	78	37	67	33
Approaches	67	32	71	33	85	41
Emergent	47	23	50	23	51	25

The collected data were entered in Excel and IBM SPSS Statistics 25 for analysis and to look for significant statistical differences. Randomization was performed on the total population samples from 2016–2017, the first year of implementation and 2017–2018, the second year of implementation to find a 30% study sample to be compared to the baseline population from 2015–2016, the year before implementation. Central tendency data was calculated and used to create histograms of English Language Arts/Literacy SBAC scores, as shown in Figures 10, 11, and 12, which showed that the data collected to answer research question 2 were positively skewed for all three years of the study.

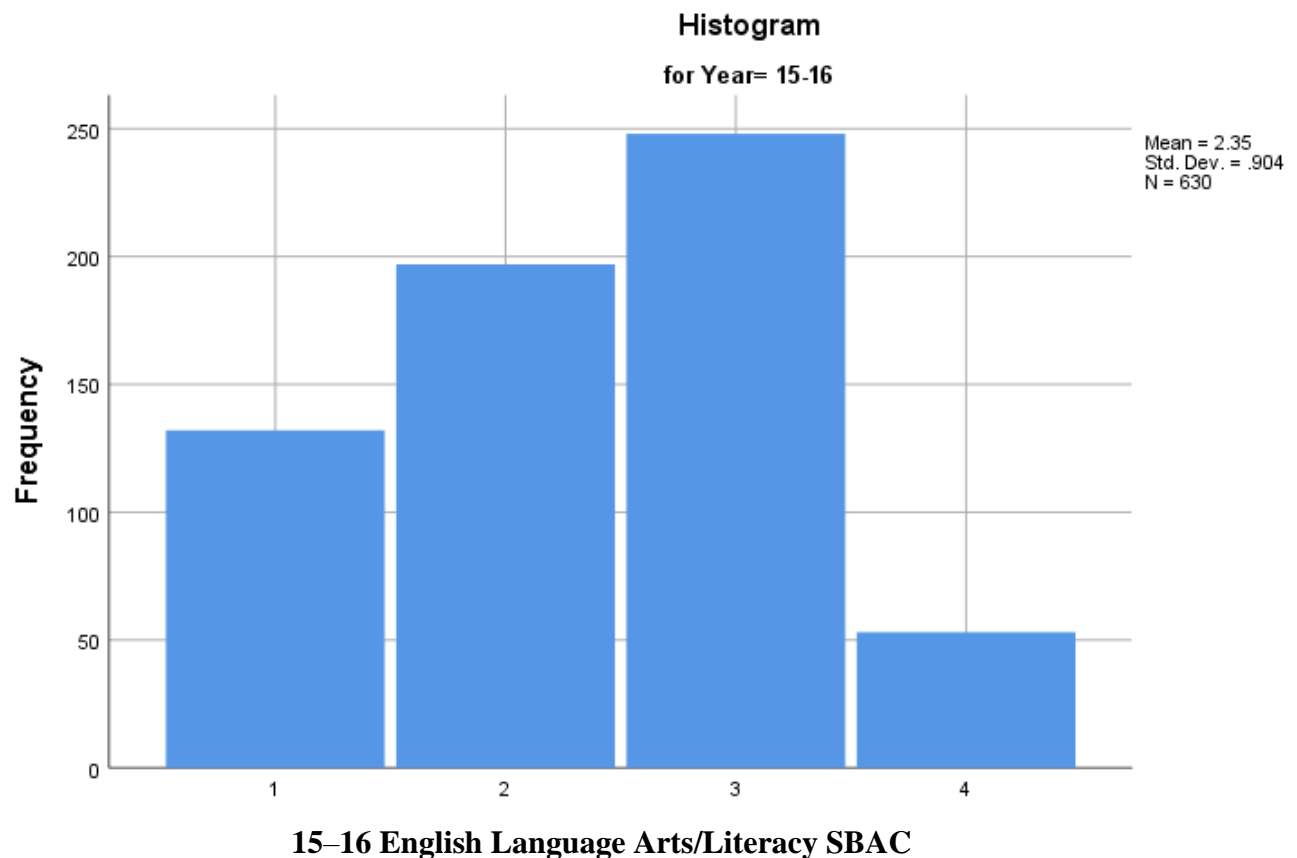


Figure 10. Histogram showing frequency of English Language Arts/Literacy SBAC achievement level scores for 2015–2016, year before implementation.

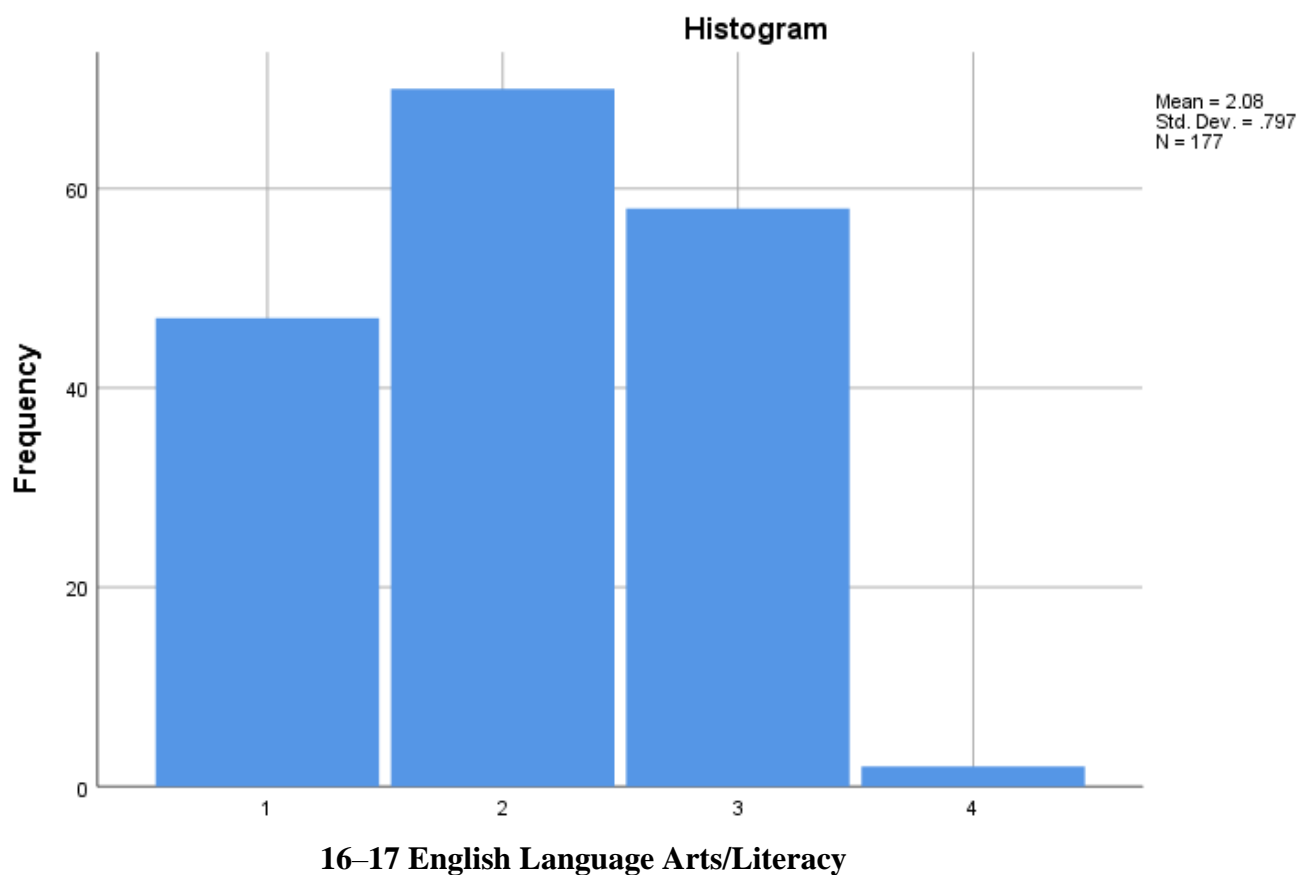


Figure 11. Histogram showing frequency of English language arts/literacy SBAC achievement level scores for 2016–2017, first year of implementation.

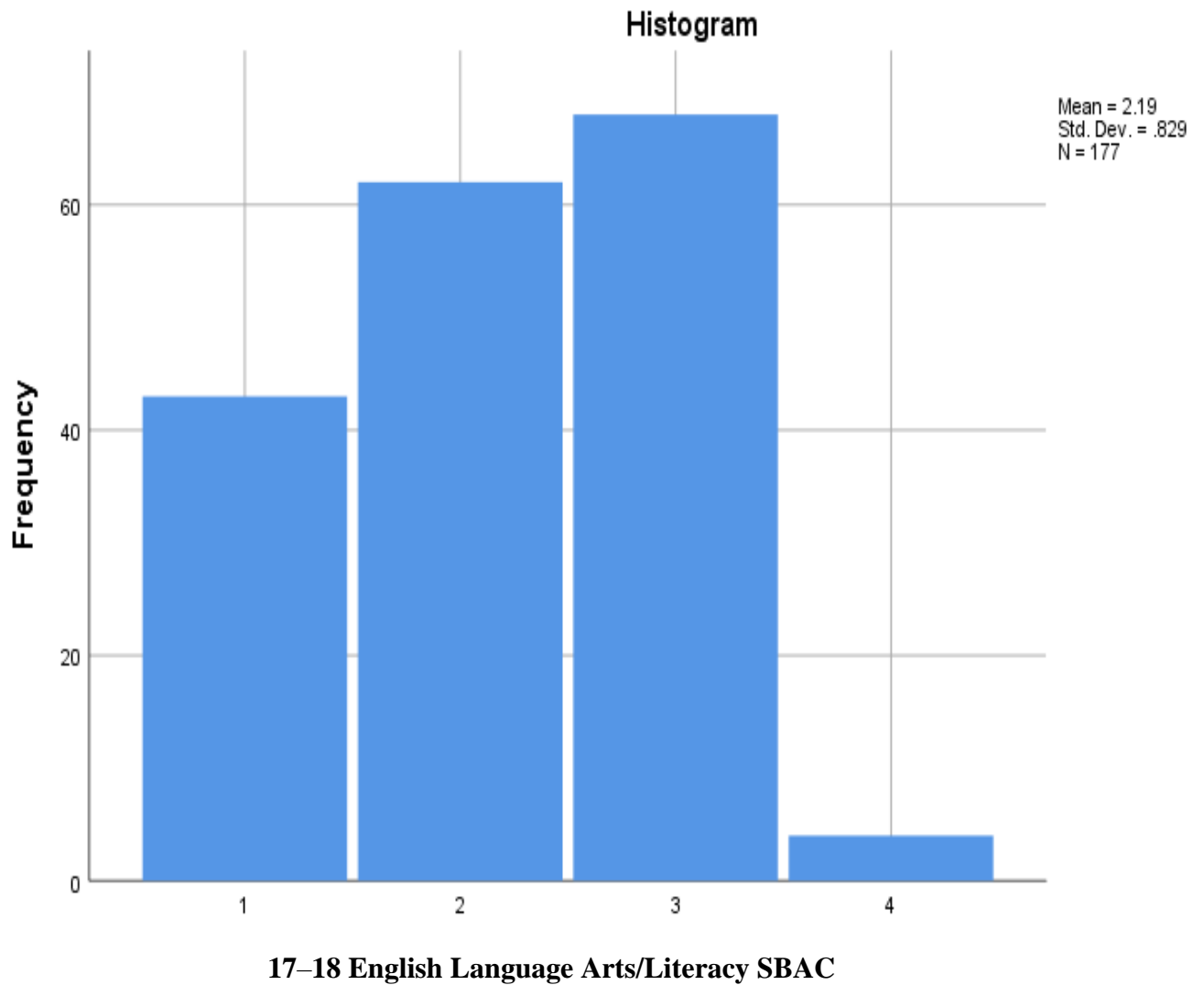


Figure 12. Histogram showing frequency of English Language Arts/Literacy SBAC achievement level scores for 2017–2018, second year of implementation.

The mean for the year before implementation was the highest of the three years $M = 2.35$, with the second year of implementation $M = 2.19$ being second highest and the first year of implementation $M = 2.08$ being third. For the first year of implementation the distribution led with the Approaches (2) as the most frequent achievement level followed by Meets (3), then Emergent (1), and finally Exceeds (4). However, for the year before implementation and the second year of implementation the pattern of frequency showed the Meets (3) level as the highest

followed by Approaches (2), Emergent (1), and Exceeds (4). From the histograms it is apparent that the Meets (3) and Exceeds (4) levels for the year before implementation when totaled together are still lower in frequency than the Approaching (2) and Emergent (1) achievement levels. This pattern holds true for the first two years of implementation as well. The majority of students at Meets (3) and Exceeds (4) levels are so much higher the year before implementation explaining why the $M = 2.35$ is higher than the means $M = 2.08$, $M = 2.19$ for the first two years of implementation. The histogram indicted students are not meeting the set standard in English Language Arts/Literacy at the same frequency as they are scoring below the standard. A one-sample t test was conducted using IBM SPSS 25 for SBAC English Language Arts/Literacy scores for the year before implementation and the first year of implementation to find the difference in means, if any. The procedure was then repeated between the year before implementation and the second year of implementation.

Detailed Analysis

The purpose of this quantitative, non-experimental research was to determine the effect a one-to-one computing environment has on student academic achievement means at a rural middle school campus in rural Nevada. Each research question was approached with both a null and an alternate hypothesis. All statistical tests were conducted using IBM SPSS 25. A detailed examination of the statistical analysis used to address the significance of each hypothesis follows and is categorized by academic achievement subcategories.

End of year GPAs. To address research question 1, Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not, the null hypothesis (H_0) was tested. A causal-

comparative methods approach was used to calculate the mean from the data set of students' end-of-year grade point averages comprised of semester grades in math, English, social studies, and science for 2015–2016, the year before implementation and 2016–2017, the first year of one-to-one computer implementation. There were 659 participants in 2015–2016 and 219 participants in 2016–2017, for a total of 878 study participants. A one-sample *t*-test was run to determine whether there were differences in academic achievement in the form of GPA between 2015–2016, the year before one-to-one computer implementation and 2016–2017, the first year of implementation, as defined by a baseline mean of 2.57. GPA scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2016–2017 mean GPA score ($M = 2.54$, $SD = 1.09$) was lower than the 2015–2016 baseline GPA score of 2.57, a statistically significant mean difference of $-.031$, 95% CI $[-.18, .12]$, $t(218) = -.415$, $p = .678$. Table 7 showed that a $.678$ *p*-value was not a statistically significant difference in academic achievement in the form of GPA scores between 2016–2017, the first year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was retained.

Table 7

Summary of One-Sample T-test Between GPAs for 2015–2016, the Year Before Implementation and 2016–2017, the First Year of Implementation

Variables	2015–2016 GPAs	2016–2017 GPAs	Total
<i>N</i>	659	219	878
Mean	2.56721	2.53919	
SEM	.040069	.074217	
SD	1.028601	1.098315	
t-Test (<i>t</i>)			-.415
<i>Df</i>			218
<i>p</i> -value			.678

$p < 0.05$

Table 8 indicated there were 659 participants in 2015–2016, and 220 participants in 2017–2018 for a total of 879 study participants. A one-sample *t*-test was run to determine whether there were differences in academic achievement in the form of GPA between 2015–2016, the year before one-to-one computer implementation and 2017–2018, the second year of implementation, as defined by a baseline mean of 2.57. GPA scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2017–2018 mean GPA score ($M = 2.67$, $SD = .984$) was higher than the 2015–2016 baseline GPA score of 2.57, a statistically significant mean difference of .096, 95% CI [-.03, .23], $t(219) = 1.455$, $p = .147$. Table 8 showed that a .147 *p*-value was not a statistically significant difference in academic achievement in the form of GPA scores between 2017–2018, the second year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was retained.

Table 8

Summary of One-sample T-test Between GPAs for 2015–2016, the Year Before Implementation and 2017–2018, the Second Year of Implementation

Variables	2015–2016 GPAs	2017–2018 GPAs	Total
<i>N</i>	659	220	879
Mean	2.56721	2.66648	
SEM	.040069	.066312	
SD	1.028601	.983562	
t-Test (<i>t</i>)			1.455
<i>Df</i>			219
<i>p</i> -value			.147

$p < 0.05$

SBAC math scores. To address research question 2, Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and

English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did, the null hypothesis (H_0) was tested. IBM SPSS 25 was used to calculate the central tendency of SBAC scores in math for 2015–2016, the year before implementation and 2016–2017, the first year of one-to-one computer implementation. Randomization of 30% of the total population for the first and second years of implementation was performed. Table 9 showed there were 630 SBAC math scores in 2015–2016 and 188 in 2016–2017 for a total of 816. A one-sample *t*-test was run to determine whether there were differences in academic achievement in the form of SBAC math scores between 2015–2016, the year before one-to-one computer implementation and 2016–2017, the first year of implementation, as defined by a baseline mean of 2.06. SBAC math scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2016–2017 mean SBAC math score ($M = 1.83$, $SD = .783$) was lower than the 2015–2016 baseline GPA score of 2.06, a statistically significant mean difference of $-.23$, 95% CI $[-.34, -.12]$, $t(187) = -4.033$, $p = .0001$. Table 9 showed that a *p*-value of $.0001$ which is less than the established $p < 0.05$ is a statistically significant difference in academic achievement in the form of SBAC math scores between 2016–2017, the first year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was rejected in favor of the alternate hypothesis (H_a).

Table 9

Summary of One-sample T-test Between SBAC Math Summative Scores for 2015–2016, the Year Before Implementation and 2016–2017, the First Year of Implementation

Variables	2015–2016 Math	2016–2017 Math	Total
N	628	188	816
Mean	2.06	1.83	
SEM	.037	.057	
SD	.927	.783	
t-Test (<i>t</i>)			-4.33
<i>Df</i>			187
<i>p</i> -value			.0001
<hr/> <i>p</i> < 0.05 <hr/>			

Table 10 showed there were 630 SBAC math scores in 2015–2016 and 184 in 2017–2018 for a total of 814. A one-sample *t* test was run to determine whether there were differences in academic achievement in the form of SBAC math scores between 2015–2016, the year before one-to-one computer implementation and 2017–2018, the second year of implementation, as defined by a baseline mean of 2.06. SBAC math scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2017–2018 mean SBAC math score ($M = 2.03$, $SD = .911$) was lower than the 2015–2016 baseline GPA score of 2.06, a statistically significant mean difference of $-.027$, 95% CI $[-.16, .11]$, $t(183) = -4.08$, $p = .0001$. Table 10 showed that a *p*-value of .0001 which is not a statistically significant difference in academic achievement in the form of SBAC math scores between 2017–2018, the second year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was retained.

Table 10

Summary of One-sample T-test Between SBAC Math Summative Scores for 2015–2016, the Year Before Implementation and 2017–2018, the Second Year of Implementation

Variables	2015–2016 Math	2017–2018 Math	Total
<i>N</i>	628	184	814
Mean	2.06	2.03	
SEM	.037	.067	
SD	.927	.911	
t-Test (<i>t</i>)			-4.08
<i>Df</i>			183
<i>p</i> -value			.684

$p < 0.05$

SBAC English Language Arts/Literacy scores. To address research question 2, Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did, the null hypothesis (H_0) was tested. IBM SPSS 25 was used to calculate the central tendency of SBAC scores in English Language Arts/Literacy for 2015–2016, the year before implementation and 2016–2017, the first year of one-to-one computer implementation as well as 2015–2016, the year before implementation and 2017–2018, the second year of one-to-one computer implementation. Randomization of 30% of the total population for the first and second years of implementation was performed. Table 11 showed there were 630 SBAC English Language Arts/Literacy scores in 2015–2016 and 182 in 2016–2017 for a total of 812. A one-sample *t*-test was run to determine whether there were differences in academic achievement in the form of SBAC English Language Arts/Literacy scores between 2015–2016, the year before one-to-one computer implementation and 2016–2017, the first year of implementation, as defined by a baseline mean of 2.35. SBAC

English Language Arts/Literacy scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2016–2017 mean SBAC English Language Arts/Literacy score ($M = 2.13$, $SD = .837$) was lower than the 2015–2016 baseline GPA score of 2.06, a statistically significant mean difference of $-.22$, 95% CI $[-.34, -.10]$, $t(181) = -3.515$, $p = .001$. The p -value of $.001$ which is less than the established $p < 0.05$ in Table 11 is a statistically significant difference in academic achievement in the form of SBAC English Language Arts/Literacy scores between 2016–2017, the first year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was rejected in favor of the alternate hypothesis (H_a)

Table 11

Summary of One-sample T-test Between SBAC English Language Arts/Literacy Summative Test Scores for 2015–2016, the Year Before Implementation and 2016–2017, the First Year of Implementation

Variables	2015–2016 ELA/Lit.	2016–2017 ELA/Lit.	Total
N	630	182	812
Mean	2.35	2.13	
SEM	.036	.062	
SD	.904	.837	
t-Test (t)			-3.515
Df			181
p -value			.001
$p < 0.05$			

Table 12 showed there were 630 SBAC English Language Arts/Literacy scores in 2015–2016 and 177 in 2017–2018 for a total of 807. A one-sample t -test was run to determine whether there were differences in academic achievement in the form of SBAC English Language Arts/Literacy scores between 2015–2016, the year before one-to-one computer implementation and 2017–2018, the second year of implementation, as defined by a baseline mean of 2.06.

SBAC English Language Arts/Literacy scores were normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$) and there were no outliers in the data, as assessed by inspection of a boxplot. The 2017–2018 mean SBAC English Language Arts/Literacy score ($M = 2.19$, $SD = .829$) was lower than the 2015–2016 baseline GPA score of 2.35, a statistically significant mean difference of $-.16$, 95% CI $[-.29, -.04]$, $t(176) = -2.63$, $p = .009$. The p -value of $.009$ which is less than the established $p < 0.05$ in Table 12 is a statistically significant difference in academic achievement in the form of SBAC English Language Arts/Literacy scores between 2017–2018, the second year of one-to-one computer implementation and 2015–2016, the year before one-to-one computer implementation, so the null hypothesis (H_0) was rejected in favor of the alternate hypothesis (H_a).

Table 12

Summary of One-sample T-test Between SBAC English Language Arts/Literacy Summative Test Scores for 2015–2016, the Year Before Implementation and 2017–2018, the Second Year of Implementation

Variables	2015–2016 ELA/Lit.	2017–2018 ELA/Lit.	Total
N	630	177	807
Mean	2.35	2.19	
SEM	.036	.062	
SD	.904	.829	
t-Test (t)			-2.626
Df			176
p -value			.009
$p < 0.05$			

Summary

In Chapter 4, data analysis results were presented for this *ex post facto* research study pertaining to the effect a one-to-one computing environment had on student academic achievement. Academic achievement was demonstrated through the gathering of semester grades

in math, English, social studies, and science to compute an end-of-year GPA based on a standard 4.0 scale and from the Nevada SBAC test in math and English Language Arts/Literacy. Means were computed for the year before implementation and the first two years of one-to-one implementation and compared. Two research questions, each with a null (H_0) and alternate (H_a) hypothesis, guided data collection and this study.

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

The underlying hypotheses used to conduct the research for this study were:

Hypotheses for GPA Scores

H_{10} . There is no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

H_{1a} . There is a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did.

Hypotheses for SBAC Scores

H2₀. There is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

H2_a. There is a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students that did.

Data were reported with regards to the hypotheses for each research question. Descriptive statistics such as means, medians, standard deviations, percentages, and z-scores were used to analyze the data statistically. Histograms, bar graphs, and box plots were used to establish negative or positive skew for all collected data. Shapiro-Wilk's test for equal distribution were conducted on variables. One-sample *t-tests* were run using IBM SPSS Statistics 25.

For research question 1, the null hypothesis (H1₀) followed the supposition that there would be no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did, while the alternative hypothesis purported there would be a significant difference in mean scores. The data and analysis revealed that there was not a statistically significant difference between the independent variable of one-to-one computer implementation and the dependent variable of students' end-of-year GPA means in either of the two years of one-to-one computer implementation when compared to the year before implementation. Table 7 with a p-value of (.678) and Table 8 with a p-value of (.147) are both more than the predetermined alpha (.05).

This quantitative finding supports retaining the null hypothesis (H_0) that there was no difference in academic achievement in the form of student GPAs for the two years of one-to-one computer implementation.

For research question 2, the null hypothesis (H_{20}) followed the supposition that there is no significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Tests between middle school students who participated in a one-to-one computing environment and students who did not, while the alternative hypothesis purported there would be a significant difference in mean scores. The causal-comparative analysis revealed a statistically significant difference of the independent variable of one-to-one computer implementation on the dependent variable of SBAC mean scores in math for the first year of implementation when compared to the year before implementation indicated by a p-value of (0.0001) shown in Table 9. The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}). However, the one-sample *t-test* for the second year of implementation and the year before implementation showed a statistically insignificant difference with a p-value of (.684) shown in Table 10. In this case the null hypothesis (H_{20}) must be retained.

The quantitative analysis for the results of research question 2 and the SBAC English Language Arts/Literacy scores revealed a statistically significant difference of the independent variable of one-to-one computer implementation on the dependent variable of SBAC mean scores in English Language Arts/Literacy for the first year of implementation when compared to the year before implementation as indicated by the p-value of (.001) in Table 11. The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}) indicating that the inception of one-to-one computers did have an effect on academic achievement in the form of

SBAC English Language Arts/Literacy mean scores. Table 12 also revealed a statistically significant difference of the independent variable of one-to-one computer implementation on the dependent variable of SBAC mean scores in English Language Arts/Literacy for the second year of implementation when compared to the year before implementation indicated by a p-value of (.008). The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}) indicating that SBAC English Language Arts/Literacy scores improved for two years with the implementation of one-to-one computers. In Chapter 5, further analysis will be applied to the findings, results will be interpreted, and ideas will be explored for future implementation and research of one-to-one computing environments on academic achievement in school-wide settings.

Chapter 5: Discussion and Conclusion

Introduction

The purpose of this quantitative, non-experimental research was to determine the effect a one-to-one computing environment has on student academic achievement means at a rural middle school campus in rural Nevada. Specific research questions were formulated to gather data concerning the effect of a one-to-one computing environment where all students and teachers had access to Chromebooks during instruction. Research question 1 was designed to examine student achievement represented by grade point average (GPA) means comprised of semester grades in each of the four core classes required in Nevada namely math, English, social studies, and science. These grade point averages were calculated on a 4.0 scale where A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0. Research question 2 looked at academic achievement in the form of achievement level mean scores on the Smarter Balance Assessment Consortium (SBAC) Tests in Math and English Language Arts/Literacy. Four achievement level scores were Level 4 = Exceeds, Level 3 = Meets, Level 2 = Approaches, and Level 1 = Emergent; these represent the proficiency a student shows in the standard material a student should know for the subject being tested. The study looked at the first two years (2016–2017, 2017–2018) of one-to-one Chromebook implementation at Middle School A and compared the gathered data with a computed mean from the year before implementation (2015–2016). In this chapter, the researcher provided a summary of the results, a discussion of the results, how the results relate to the literature, limitations of the study, implications of the results for practice, policy, and theory, recommendations for further research, and concluding remarks.

Summary of the Results

The research questions that governed this study on student academic achievement during school-wide implementation of one-to-one student-issued laptop computers included:

RQ1. Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and those that did not?

RQ2. Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not?

Even though technology has flooded society and has been a part of educational initiatives for some time now, one-to-one computing is still in its infancy as far as pedagogical theories are concerned. Little research exists on the effect a one-to-one computer environment has on academic achievement with regards to grade point average and standardized testing means (Fleischer, 2012), especially at the middle school level. “One-to-one computing in public schools” (2008) reported administrators and educators demonstrated hope for one-to-one device programs to increase academic achievement and student engagement, while reducing the digital divide by increasing the economic competitiveness of students through acquisition of 21st century skills.

The significance of the study at Middle School A was to examine the gap that exists in the literature where academic achievement is concerned and in a theoretical sense add further knowledge and credence to the study of school-wide one-to-one computing environments at the middle school level. The theory that was the basis for this study is the learning theory of

constructivism. In the last two decades education has experienced a shift in thought about the way humans learn and the conditions which allow learning to occur (Applefield et al., 2001). Constructivism “equates learning with constructing meaning from experience” (Cooper, 1993, p. 13). The shift in theory that has been increasingly used in designed instruction in education has moved from behaviorism to cognitivism and now to constructivism (Cooper, 1993).

Constructivism as a paradigm shift posits that learning is an active, constructive process (David, 2015). Constructivism was chosen as a conceptual framework for this study because it represents a shift in epistemology of knowledge and theory of learning and is undoubtedly one of the most influential perspectives of learning to impact education during the last 20 years (Applefield et al., 2001). Constructivism also utilizes cooperative learning groups to teach multiple perspectives and problem solving by creating critical thinkers who possess 21st century student skills that engage in real world activities and problem-based learning. One-to-one computing embodies constructivism, in which students explore how to build their own knowledge of a subject (Apple Computer, Inc. 1991).

Seminal Literature

One-to-one computer implementation in education has been driven by computer manufacturing companies. Seminal research began in 1985 when Apple launched the first one-to-one computing program in two schools (Bosco, 2015). The Apple Classrooms of Tomorrow (ACOT) initiative was intended to be a long-term research project that would examine how access to interactive computer technologies cause learning and teaching to change in the classroom for both students and teachers (Apple Computer, Inc., 1991). Apple’s original one-to-one computer initiative was the springboard for all other research studies.

While Apple was the leader in one-to-one computing, other computer companies saw the potential for growth and came up with their own initiatives. Microsoft's Anytime, Anywhere Learning program flooded schools with the opportunity for students to lease or buy laptop computers in the mid-1990s (Penuel, 2006). Penuel (2006) explained that the most common concept of the early one-to-one computer initiatives was that the student had individual access to a computer no matter what administrative policies were put into place. Basically, each school or school district could decide whether the student took the computer home, if there was a cost involved, and what program goals would be developed (Penuel, 2006). Bosco (2015) noted that 2015 marked the 30th anniversary for one-to-one computing in schools.

Most of the research that has been conducted on one-to-one computer environments focused on the social research aspects of finding out how technology integration affects the perceptions and attitudes of students and teachers (Bixler, 2016; Clarke, 2016; Crooks, 2016; Heath, 2015; Spanos & Sofos, 2015). Often, educators worry more about how everyone feels about a new pedagogy through qualitative exploration and leave the quantitative or nitty gritty of how successful the new method is to research down the road. If everyone feels good about a new initiative, somehow that will perpetuate its success. However, questions of whether technology is good for education, enjoyable, or just a passing phase are a moot point. Technology is here to stay and is a required 21st century skill for students to be able to function in a global world and be successful. The logical need to research and discover how to begin a one-to-one implementation and keep it growing has been covered, and now it is time to begin to research on the effect a one-to-one computer environment has on academic achievement.

How to implement and provide the staff vital training that they need to be successful in all aspects of a one-to-one computer initiative is the next well-studied area among computer

implementation research (Clarke, 2016; Grant, 2016; Simmons, 2015; Topper & Lancaster, 2013; Zheng et al., 2016). Hayes and Greaves (2013) surveyed the technology programs in 1,000 U.S. schools and reported that the research shows that effective implementation of one-to-one computer programs can lead to improved student achievement. A realistic plan with a timeline must be charted out before implementation of one-to-one computers in a school to maximize success (Grant, 2016, Hayes & Greaves, 2013; Simmons, 2015). Effective implementation of one-to-one computer initiatives can produce a significant return on financial investments when the time is taken to plan and prepare efficiently (Clarke, 2016; Hayes & Greaves, 2013; Simmons, 2015).

New Literature

The researcher's initial search for studies about one-to-one computers discovered that most studies utilized a mixed methods research design (Bixler, 2016; Burgad, 2008; Clarke, 2016; Dennis, 2014; Grant, 2016). There were only two studies that employed a quantitative research design (Sprenger, 2010; Yamaguchi et al., 2014), but neither of them used the *ex post facto* design. The gap that the researcher discovered in the lack of one-to-one computer studies that applied the causal-comparative research design was the driving force behind the prescribed research method.

Since this study began three years ago, there have been additional studies conducted and published that are worth noting in the literature. Hanley (2018) conducted a quasi-experimental cohort study that explored educational environments that exhibited pedagogical delivery with and without technology to examine if a correlation existed in student achievement gains. The conclusion of Hanley's (2018) study was that technology alone was not enough to increase student achievement or gain academic excellence.

The gap that was originally noted in the number of quantitative research studies from the literature review specifically dealt with a lack of studies on one-to-one computer implementations at the middle school level. The realization of this gap gave significance to this study. Another study that helped to close the gap in the literature was published by Wood (2018). This quantitative, experimental study utilized 7th and 8th grade students enrolled in California Title I public middle schools as the study population (Wood, 2018). Wood (2018) explored the effect student access to Chromebooks, for at least one 46-minute instructional period a day, had on the ELA (English Language Arts) portion of the SBAC in the form of writing levels and overall achievement levels. The findings reported that 7th and 8th grade general education students, 7th and 8th grade economically disadvantaged students, and 8th grade students not identified as economically disadvantaged that had access to the daily use of Chromebooks reported significantly higher results in both writing levels and overall achievement levels on the ELA SBAC (Wood, 2018). Conclusions drawn by Wood (2018) included the suppositions that the use of Chromebooks for at least 46 minutes a day benefits all students and can increase ELA writing and overall achievement levels according to results on the SBAC.

Discussion of the Results

This research study was driven by two research questions dealing with a schoolwide implementation of a one-to-one computer environment and how academic achievement, in the form of end-of-year GPAs and scores on the math and English Language Arts/Literacy SBAC assessment, was affected. The results used to answer the research questions came from using data from the year before the one-to-one computer implementation as a baseline and comparing it with data from the first and second years of implementation. Data added results to the gap that was discovered in the review of the literature and showed that future research of one-to-one

computer environments impact on academic achievement is needed. While the significance of the results were varied for both research questions, the results did hold true to the educational theory of constructivism.

Research question 1 results. For research question 1, the null hypothesis (H_{10}) followed the supposition that there would be no significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students who participated in a one-to-one computing environment and students that did not, while the alternative hypothesis purported there would be a significant difference. The data and analysis revealed that there was not a statistically significant difference between the independent variable of one-to-one computer implementation and the dependent variable of students' end-of-year GPA means in either of the two years of one-to-one computer implementation when compared to the year before implementation. Table 7 with a p-value of (.678) and Table 8 with a p-value of (.147) are both more than the predetermined alpha (.05). This quantitative finding supports retaining the null hypothesis (H_{10}) that there was difference on academic achievement in the form of student GPA means for the two years of one-to-one computer implementation.

Findings indicating that the introduction of a one-to-one computer implementation had no significant difference on academic achievement in the form of student GPA means could indicate several analyses. First, by using total population sampling some students would have been the same and some students would have been different. Second, the Nevada Ready 21 Grant did not provide any teacher training until after the school year began, so teachers may have been inadequately prepared to fully utilize the Chromebooks as an integral part of their curriculum. Third, maybe students that have had technology every day of their lives may not excel in

education by using technology, especially when the technology is taught by a non-digital native that has not been properly or adequately trained by the school district on the implementation of one-to-one devices in the classroom. Fourth, results from studies on how technology impacts academic achievement might be influenced by the number of years the one-to-one technology has been implemented. Working out the bugs of implementation might provide different results in years three to five or five to ten versus years one and two of a one-to-one computer implementation.

Research question 2 results. For research question 2, the null hypothesis (H_{20}) followed the supposition there would be no significant difference in mean scores on SBAC scores in math and English Language Arts/Literacy between middle school students who participated in a one-to-one computing environment and students that did not, while the alternative hypothesis purported there would be a significant difference in mean scores. The causal-comparative analysis revealed a statistically significant difference of the independent variable of one-to-one computer implementation on the dependent variable of Math SBAC mean scores for the first year of implementation (2015–2016) when compared to the year before implementation (2014–2015) indicted by a p-value of (0.0001) shown in Table 9. The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}). However, the one-sample *t-test* for the second year of implementation (2016–2017) and the year before implementation (2014–2015) showed a statistically insignificant difference with a p-value of (.684) shown in Table 10. In this case the null hypothesis (H_{20}) must be retained.

The transitory nature of the student population makes it very difficult to study an entire school participating in a one-to-one implementation for more than one year. The split results of a significant difference for the first year of implementation (2015–2016) and an insignificant

difference for the second year of implementation (2017–2018) when compared to the mean of the year before (2014–2015) the introduction of one-to-one computers as shown in Math SBAC mean scores could be a result of using total population sampling and not a paired sample, where the students would have been the same for all three years of data collected. The difficulty of using a paired sample in a middle school student population is that eighth grade is always advancing to the high school and fifth grade is always entering as sixth graders. Paired sample studies could only be conducted for two years and grades six and seven would be the only grades that would stay in the school for both years to be studied.

The difference in the results between year one (2016–2017) and year two (2017–2018) on the Math SBAC could be due to the amount of exposure that a student receives in the subject of mathematics. Math concepts are primarily taught in just one course, whereas English Language Arts/Literacy is taught in many classes. Math as outlined by the Nevada Academic Content Standards (NVACS), previously referred to as Common Core Curriculum (Nevada Department of Education, 2010), has begun to focus on the ability of the student to be able to explain how they arrived at their answer rather than just reaching the correct numerical answer.

The quantitative analysis of the results for research question 2 and the English Language Arts/Literacy SBAC revealed a statistically significant difference of the independent variable of one-to-one computer implementation on the dependent variable of English Language Arts/Literacy SBAC mean scores for the first year of implementation (2015–2016) when compared to the year before implementation (2014–2015) as indicated by the p-value of (.001) in Table 11. The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}) indicating that the inception of one-to-one computers had a difference on academic achievement in the form of English Language Arts/Literacy SBAC mean scores. Table 12 also revealed a

statistically significant difference of the independent variable of a one-to-one computer implementation on the dependent variable of English Language Arts/Literacy SBAC mean scores for the second year of implementation (2016–2017) when compared to the year before implementation (2014–2015) indicated by a p-value of (.008). The null hypothesis (H_{20}) must be rejected in favor of the alternate hypothesis (H_{2a}) indicating that English Language Arts/Literacy SBAC mean scores improved for two years with the implementation of one-to-one computers.

Data that indicated a one-to-one computing environment had a significant difference on student achievement in the form of English Language Arts/Literacy SBAC mean scores could be in part due to the fact that one-to-one computers were used in three of a students' core subjects, namely English, social studies, and science. The exposure to a technology enhanced one-to-one computer environment a student received in the three classes of English, social studies, and science could be a factor in statistically significant data reported over the first two years of implementation. One-to-one device immersion in three subjects versus only one subject reported on the Math SBAC could be a logical rationale for the difference in findings. A strong aspect of constructivist pedagogy is the repetition of a concept until a student can then teach the concept on his or her own. Basically, the more technology immersion students receive, the better they are at retaining the information and sharing it with others.

Discussion of the Results in Relation to the Literature

Yamaguchi et al. (2014) concluded that even though the educational rationale for one-to-one computing programs is based on improving the quality of education by increasing student achievement, 21st century learning skills, and internal efficiency, the actual effect of one-to-one device programs on academic achievement is not known. Hu (2007) ascertained that some schools have canceled their one-to-one programs because evidence of achievement was lacking.

This establishes a clear need for research that evaluates a one-to-one device program which focuses specifically on its impact on student achievement. The purpose of this quantitative, non-experimental research study was to determine the effect a one-to-one computing environment had on student academic achievement means at a rural middle school campus in rural Nevada. The implicated results of this study on the community of practice come directly in response to the purpose of this study. Due to the lack of study information on how one-to-one computing environments impact student academic achievement means, quantitative study data is valuable to school administration in deciding if a one-to-one computing environment will enhance student achievement and should be continued, refined, or discontinued (Bennett et al., 2008; Sheninger, 2014; Xiaoqing et al., 2013).

The data of this study for research question 1 showed no significant difference in end-of-year student GPAs for both the first (2016–2017) and second (2017–2018) years of implementation. The data for research question 2 showed both a significant difference of first year (2016–2017) Math SBAC mean scores and an insignificant difference of one-to-one computer implementation on the second year (2017–2018) of Math SBAC mean scores as well as significant results on English Language Arts/Literacy SBAC mean scores for the first (2016–2017) and second (2017–2018) years of implementation when compared to a before computer implementation mean of student GPA and standardized test scores. The aforementioned results leave this researcher wondering whether one-to-one computing environments impact student achievement as much as society thinks. Kivunja (2014) stated that “teaching learners without a firm grasp of how they learn is like trying to erect a building on shifting sand” (p. 95). Prensky (2015) coined the term digital natives to describe students born into the digital age with computers, gaming, and the internet always at their disposal. The students of today and

tomorrow will all be digital learners. This study does confirm that teachers must begin to understand how digital natives learn best (Kivunja, 2014; Prensky, 2012; Sheninger, 2014). Do digital natives learn better when a computer device is involved, or are the non-digital natives that are still teaching not utilizing one-to-one implementations in a way that would produce positive change on student academic achievement? Half of the data in this study indicate yes, but the other half of the data indicate no, which substantiates the need for more research with regards to one-to-one computing environments' impact on student academic achievement (Hu, 2007; Yamaguchi et al., 2014). Such inconclusive results as to whether a one-to-one computing environment is the best pedagogical method to influence student academic achievement suggests that both teachers and administrators must take a more in-depth look at how digital natives learn best.

Data for research question 1 showed no significant difference of a one-to-one computing environment on student academic achievement in the form of end-of-year grade point average means comprised of semester grades in math, English, social studies, and science. Neither of the first two years (2016–2017, 2017–2018) of one-to-one device implementation showed a significant difference on GPA means when compared to the year before implementation (2015–2016). The data also revealed no significant difference for research question 2 on the Math SBAC means for the second year of implementation (2017–2018). Heath (2015) reported similar findings in a study with high school students from 33 different schools in multiple states involved in a one-to-one computer implementation. Data showed that the average student ACT composite scores and ACT subtest scores in English, math, and reading were not statistically different after two years of one-to-one device implementation (Heath, 2015). Hanley (2018) also reported no significant data to support that one-to-one computers had any difference on student

achievement means. The findings from research question 1 and research question 2, Math SBAC the second year of implementation, are also concurrent with Hu's (2007) claim that school districts are abandoning one-to-one programs due to a lack of evidence that academic achievement is improved by use of one-to-one computers. Furthermore, the lack of significant data that one-to-one computer environments have on student achievement means correlates with the literature review of one-to-one computer initiatives Fleischer (2012) conducted that concluded the correlation between one-to-one computers and student academic achievement was ineffectual and inconclusive.

For research question 2, the data concluded that a one-to-one computing environment had a significant difference on student mean scores on the Math SBAC the first year of implementation and the English Language Arts/Literacy SBAC for both the first and second year of implementation. All data measured were from the total population sample for grades six through eight for both years of one-to-one implementation. This correlates directly with data reported by Wood (2018) where 7th and 8th grade students showed significant gains in scores on both English Language Arts/Literacy SBAC writing levels and overall achievement levels after receiving 46 minutes daily of a one-to-one computer environment. Wood (2018) concluded that socioeconomic status was ineffectual to the results and supposed that a one-to-one computing environment was bridging the achievement gap caused by the digital divide and a lack of technology access to students that do not have computers in their homes.

The quantitative findings from this study lend credence to the data from studies by Clark (2016) and Gillard (2011). Clark (2016) indicated a significantly high correlation with reading achievement on MAP tests when laptops were used outside of the classroom for homework and learning. Likewise, the results reported from this study included 24/7 student access to the

Chromebooks and support Gillard's (2011) survey of 364 administrators from large school districts with one-to-one computer initiatives reported that 78% of school leaders felt laptops had a moderate or significant impact on student achievement. The significant data reported from student scores on the English Language Arts/Literacy SBAC from this study combined with Wood's (2018) data add to the concentration of information that Clark (2016), Pennuel (2006), and Storz and Hoffman (2013) indicated was long past due.

Even though this researcher's study did not specifically focus on the implementation aspect of one-to-one computing, it is worth noting that the equivocal results could be directly related to the methods that were used at Middle School A in this implementation. One of the biggest key issues to implementing mobile learning in the form of one-to-one devices is training educators (Chen et al., 2015; Hayes & Greaves, 2013; Simmons, 2015; Smith III, 2013; Whitby, 2014). The Nevada Ready 21 Grant provided the Chromebooks and mandated a one-time online course for teachers to take, but Middle School A did very little to train the teachers and staff for the rollout of the one-to-one implementation.

Limitations

In a world that strives for perfection or to be the best, limitations are often seen as a hindrance and may be regarded as a negative aspect of research. The beauty of the nature of research and pedagogy is that a limitation can be turned into a learning tool that helps to build the scaffolding of experience. In this country the drive is to improve our students' abilities to compete in a technologically focused global workplace. The 21st century learning skills that have become the springboard for initiatives and grant funded one-to-one computer initiatives come with excitement in innovation and limitations that both open the door to forward progress and allow it to slowly close again. Issues such as the effectiveness of technology in education for

a population of millennials that have had technology in their hands since birth is debatable and worth further scrutiny.

The original proposal of this study on one-to-one computer implementation was to use the two middle schools in rural Nevada that had been chosen for the Nevada Ready 21 Grant to implement Chromebooks to all students and staff to gather the needed academic data to answer the research questions. Many limitations were encountered during the time of this study. One of the most significant limitation that occurred was a loss in electronic archival grading data for the year before the one-to-one implementation. Four computer servers at the District that held the archival data crashed simultaneously. Teachers at Middle School A had turned in hard copies of student grades, but teachers at Middle School B had not. Ironically, the reliance on archival data to be safely and securely stored did not result in the traditional hard copy of teacher gradebooks. The researcher appealed to the school principals for permission to access archival data in the form of final report cards from student cumulative files. Data collection began by the researcher physically going through each students' cumulative file to find the printed report cards and transfer the grades into an excel spreadsheet. In the beginning of this process, the researcher soon discovered that any student who had moved would not have a cumulative file and thus that student would have to be eliminated from the total population sampling method being used. This would not lend credence to the reliability and validity that was being sought by using a total population sampling method. For this reason, the researcher filed a modification with the IRB to remove Middle School B from the study. Decreasing the statistical power by removing study participants from an entire population is always a limitation and results in decreased breadth and depth to the study. Including an additional campus of students in the study population would have been more representational of the target population.

Another limitation that had significant impact on the results of this study was the transitory nature of the middle school population. Students were different each year due to promotion from the elementary level to the middle school level and students from the middle school moving to the high school level. This affected the data on GPA and standardized testing from one year to the next in not providing a paired population sample. Each year of data had to be treated independently even though some of the students remained the same. Some students would not have participated because they were not enrolled in Middle School A for all three years of gathered study data. There was also the possibility that a student moved to Middle School A with transfer grades from a school that was not participating in a one-to-one implementation, thus providing a semester grade that was not representational of a one-to-one computing environment. Also, the online SBAC was in its first year of implementation during the study years, so the State was still trying to improve upon the administration.

GPA's were calculated using final semester grades from the four Nevada required core classes of math, English, social studies, and science. There were two semesters of grades for each subject resulting in a total of eight grades that would have been averaged together and then ranked on a 4.0 GPA scale where A = 4.0, B = 3.0, C = 2.0, D = 1.0, and F = 0. Only using the four core classes instead of all the classes a student took in a year to calculate a GPA could be viewed as a limitation. Some would argue that all of a student's classes regardless of the use of one-to-one devices should be used when calculating a student's GPA. For this particular study, the insurance that the Chromebooks were used specifically in the four core courses used to calculate student GPA's was of more import to the researcher than including students' overall GPA for the entire set of classes. Chromebooks are not used in classes such as physical education or art and could arguably be considered a limitation in calculating academic

achievement in a one-to-one computer implementation research study. Likewise, the SBAC only provided online standardized tests in Math and English Language Arts/Literacy and some could argue that a lack of a specific science or social studies test for all three grade levels could limit and skew the reliability of the obtained data and its direct correlation to the four core class subjects.

The results from the SBAC Tests are tied to federal funding for schools and are reviewed comprehensively one year at a time. Schools track SBAC results to determine school improvement goals or which groups of students struggle in math or English Language Arts/Literacy. In Nevada the SBAC results are now part of a teacher's evaluation and the school's star rating indicating how well the school is ranked against other schools. Even though for long-term research purposes a paired sample might be highly desired, looking at the data yearly, as the State does, may provide valuable data. Each of the mentioned limitations could affect the data to some degree.

Implication of the Results for Practice, Policy, and Theory

Education has been one of the areas where technology has not kept pace with the digital native's lifestyle and debate about the need for educational reform to meet student's needs has ensued (Bennett et al., 2008; Sheninger, 2014; Xiaoqing et al., 2013). Technology is here to stay, and all students who are now in school have been inundated with an overdose of technological advances in their lives and educations. Previous research indicated the need to examine whether one-to-one computer implementation had an effect on academic achievement means (Clark, 2016; Pennuel, 2006; Storz & Hoffman, 2013; Yamaguchi et al., 2014). An urgent need exists to determine if one-to-one computing is the answer to improving student academic achievement and how the implication of these study results impact practice, policy and theory.

Practice. The results of this research study vary depending on the method that was used to define academic achievement. Does student buy in play a factor in the results of research studies? Studies such as this one, have been conducted, but the results are just as inconclusive. For every study that claims a positive correlation between a one-to-one computing environment and academic achievement (Clark, 2016; Wood, 2018), there is a study that does not show any significance (Henley, 2018). This study is an example of the dichotomy expressed in the results from the literature.

Significance showing a difference of one-to-one computers on academic achievement means was found in half of the data compared in this study. The first year of implementation (2016–2017) revealed a significant difference in Math SBAC mean scores and the first and second year of implementation (2016–2017, 2017–2018) revealed a significance in English Language Arts/Literacy mean scores. This leads one to believe that there is certain credence to the claim that one-to-one computing has a difference on student academic achievement in the form of SBAC mean scores or standardized test mean scores. What is not clear is whether one-to-one computers have a difference on student academic achievement in the form of GPA mean scores. The results from this study support the need for more research specifically dealing with one-to-one computer environments and how student end-of-year GPA mean scores are impacted.

Standardized testing is common practice in the public-school system and is used to represent student academic achievement (Bergmann, 2014). For research, it may make sense to focus on studies that use a standardized test as the instrument to test levels of academic achievement in a one-to-one environment, because the standardized test has been proven and may have a high correlation coefficient. However, standardized tests have existed long before one-to-one computing was introduced, suggesting that the correlation coefficients for these tests

were established before students were receiving one-to-one computer environments as a new pedagogy. For this reason, a study looking into the accuracy of correlation coefficients with regards to students that are part of a one-to-one computer environment and taking the standardized tests would be helpful and crucial to determining the accuracy of the effect a one-to-one computing environment has on academic achievement.

Policy. Sprenger (2010) discovered that teachers' teaching styles change in all subject areas regardless of the years of experience possessed by the teacher in a one-to-one computer environment. The significant results of this study in favor of one-to-one computing might suggest that the teachers in subjects where digital devices were utilized as part of the day to day instruction provided students with a more enjoyable learning experience. Students that were part of previously studied populations reported enjoying one-to-one computing devices and find attending school more pleasurable when technology is used in the classroom (Bixler, 2016; Burgad, 2008; Clarke, 2016; Spanos & Sofos, 2010; Stortz & Hoffman, 2013). The reality is most digital natives would much rather spend their time on a digital device than listen to a teacher lecture or even spend time in discussion. While students enjoy spending time on digital devices, do teachers enjoy teaching with them and is this the best pedagogical method to attain growth in academic achievement? Looking at research data and deciding on policies to help implement one-to-one computing environments in a way that will have the greatest impact on academic achievement is paramount to any school implementing one-to-one computers.

Theory. Constructivism was the main theory that guided this research study. A one-to-one computer environment promotes the basic concepts of constructivist pedagogy. According to Burgad (2008), Clark (2016), and Zheng et al. (2016) when students are more engaged and motivated, they are active participants in the learning process, which can lead to increased

student achievement. The significant findings of the effect a one-to-one computer environment has on the English Language Arts/Literacy SBAC mean results for the first two years of Chromebook implementation (2016–2017, 2017–2018) and the first year of implementation (2016–2017) on the Math SBAC mean scores perpetuates the constructivist theory that a more active role in the learning process increases student engagement and motivation and thus student achievement (Burgad, 2008; Clark, 2016; Zheng et al., 2016). Student achievement has become of great concern as college retention rates are dropping and an estimated 40–60% of high school students must take remedial courses in math and English their first year of higher education (Jimenez et al., 2016). Many have hypothesized that one of the reasons is a lack of technological progress in education to meet the current learning style of digital natives (Kivunja, 2014; Prensky, 2012; Sheninger, 2014).

Unfortunately, the most common way of determining the success of technology on academic achievement is currently by using standardized testing that has now been computerized in an attempt to keep up with technological advances. The SBAC, MAP, ACT, SAT, etc. are all given in online formats, but does the standardized test truly convey whether a one-to-one computing environment has had an effect on academic achievement means? Advocates for constructivism would argue no. Bruner (2009) felt that a constructivist learning style better promoted active engagement and motivation in learning, while tailoring a student's experience through creativity and problem solving. A standardized test does not allow for any tailoring of individual experience or creative problem solving. The name alone suggests that every participant conform to expressing a rigid set of knowledge. While Clark (2016), Pennuel (2006), Storz and Hoffman (2013), and Yamaguchi et al. (2014) have made cases for the need for more studies on the effect a one-to-one computing has on academic achievement, this study upholds

the need for an examination into the legitimacy of using standard tests to assess academic achievement means when one set of data find significant results and another set of data does not.

Recommendations for Further Research

The duality of the results for both research questions demand further research on the effect a one-to-one computer environment has on student academic achievement means. These findings are consistent with many researchers' pleas for more research (Clark, 2016; Pennuel, 2006; Storz & Hoffman, 2013; Yamaguchi et al., 2014). The gap that was first noticed among previous research dealt not only with the effect a computer environment had on academic achievement means, but also with academic achievement being defined as a student grade point average and school-wide one-to-one computer initiatives specifically at the middle school level. Many studies focus on one grade level or one subject (Clark, 2016; Hile, 2015; Yamaguchi et al., 2014). This study has provided data to close this gap, but further research focusing on school-wide one-to-one implementations, research at the middle school level, and research specifically looking at how one-to-one computers affect academic achievement in the form of GPAs is still needed.

Even though this study was not qualitative in nature and did not specifically focus on the perceptions of stakeholders involved in a one-to-one computer implementation, the researcher's presence on campus at Middle School A afforded unique insight into specific topics where more research is needed such as perceptions from students, teachers, and parents, implementation downfalls, and successes. One of the biggest key issues to implementing mobile learning in the form of one-to-one devices is training educators (Chen et al., 2015; Hayes & Greaves, 2013; Livingston, 2012; Simmons, 2015; Whitby, 2014). Shea (2016) posited the importance of

teachers receiving training before a one-to-one computer implementation and time to be able to incorporate the training into curriculum for the upcoming year.

All teachers at Middle School A took a required class that was online at the beginning of the year in conjunction with the grant that included modules on tools, apps, G Suite for Education, classroom management, and curriculum integration. Teachers were overwhelmed at the amount of work involved in the class as they were trying to begin a new school year. Many teachers struggled to incorporate the Chromebooks in their classes the first year and some subjects like PE or Family Consumer Science have not incorporated the Chromebooks into the curriculum at all. If a teacher is not going to utilize student laptops in the classroom, then school-wide implementation will suffer (Simmons, 2015). Barriers to success expressed by teachers include a lack of technology knowledge and understanding of specific device use, insufficient professional development, and being overwhelmed at the immensity of incorporating one-to-one computers in the classroom (Clarke, 2016; Crooks, 2016; Grant, 2016; Hile, 2015; Simmons, 2015;). Future studies specifically focusing on what is needed to implement one-to-one computers in a school are greatly needed to expand the research in a broad and comprehensive manner. More quantitative or mixed methods studies covering these topics would be desirable. School administrators, teachers, school boards, and general stakeholders need further information to guide this type of pedagogy

Chromebooks presented new challenges in classroom management. The researcher had the opportunity to substitute in a 6th grade science class where students were using their Chromebooks. The class was very quiet, but it was difficult to get the students off the Chromebooks to interact and take notes. The researcher also noticed that after school during drama rehearsal the Chromebooks became a complete distraction and students missed cues and

did not pay attention to what was going on at all. Students seem to enjoy Chromebooks for free time and personal use, but not for educational purposes. The most exciting response from students' using Chromebooks for educational purposes that the researcher witnessed was when 8th grade social studies students were using Quizlet to study for their upcoming chapter test. Quizlet allows students to compete against each other while answering pre-entered questions by the teacher. The questions are timed, so it is fast paced, and the program keeps track of scores and gives individual encouragement to students on their computer screens. The teacher can also enter encouraging comments with pictures for the entire class to see as questions are answered correctly. Additional studies on the ways in which one-to-one devices are being used for pedagogy and if those methods are successful to academic achievement are needed. Is the computer a learning device or a glorified study tool or word processor? More studies pinpointing the types of learning that are occurring when one-to-one devices are used and how to help teachers successfully integrate the technology to its highest pedagogical potential are necessary for the growth of mobile learning.

Unfortunately, the access to Chromebooks has also caused instances of cyberbullying, finding and distributing pornography, chatting with people that ended up being adults posing as teens, more incidents of students looking up information on suicide and self-harm, and students using the chat feature to communicate with each other during instructional time. Several parents have demanded that their student not have any access to Chromebooks at home or at school. Research has shown that establishing a digital use policy that governs ethical use of digital technology and promoting digital citizenship is imperative to successful implementation (Bosco, 2015; Chen et al., 2015; Livingston, 2012; Majumdar, 2015; Whitby, 2014). All students and teachers at Middle School A were required to take a digital citizenship course as part of the

grant. Research into the success of digital citizenship and how to combat bullying and be responsibly safe on the internet would benefit parents and lawmakers in deciding that one-to-one technology is safe and worth the additional expense to education.

The sheer expense of maintaining computers for a school is worth noting (Bosco, 2015; Hayes & Greaves, 2013; Topper & Lancaster, 2013). Without a long-term sustainable plan to provide computer repair, updated devices and software, training on new software, and the staff positions to manage the devices, one-to-one computer implementations will suffer and sink into extinction. The NV Ready 21 Grant funded Chromebooks, a Digital Technology Coach, and District IT specialist for three years. Middle School A is in its final year of the grant and will be losing all funding. Since the pre-implementation leg work was not done and the school did not have to come up with the funding for this initiative, this leaves the school in a predicament in which the future of one-to-one computing will become non-existent. Chen et al. (2015) and Traxler (2009) admonished schools to provide a look at a variety of information that includes expert testimonials, technology demonstrations, and best practices before putting a one-to-one implementation into effect. The Chromebooks that are currently at the school will not be under warranty anymore, and all repairs will become the school's responsibility. The digital technology coach will still be in the building, but she will be teaching 6th grade math and will be unavailable for on-the-spot tech support. There was no long-term planning that was set aside for the one-to-one implementation to become self-sustainable. Shoptalk indicates that most likely the school will return to carts of computers that will be checked out from the library to teachers. This becomes a huge limitation during the mandated school-wide testing for the MAP test given three times a year, the SBAC testing, and the current daily intervention program i-Ready that is run completely on a computer. Further research on how schools have and can sustain a long-term

one-to-one schoolwide implementation would benefit school districts in knowing how to prepare to fund a one-to-one computer program. This type of research could also benefit computer companies in knowing and understanding what is needed most for schools to get the most bang for their buck when purchasing one-to-one devices for students. Additional research on how to incorporate BYOD or bring your own device programs would also be helpful to schools to know if allowing students to BYOD would help alleviate the cost enough to be a viable option or if the hassle of hooking personal computers to networks and not being able to control the usage would be too much of a headache.

Conclusion

The sheer immersion of technology in the life of a digital native is mind blowing. Pedagogy is being called upon to meet the needs of these digital natives who exhibit different learning styles. Understanding how to harness the power of technology in the classroom is one of the most critical questions being asked in educational institutions. Figuring out what pedagogical aspects are archaic and which ones can be enhanced with technology is a hot topic for educational reform. Constructivism urges reform in education to be student driven, creative in problem solving, inquiry based, cooperative in learning, and to use life experience to make meaning of one's surroundings. Constructivist learning theory supports one-to-one computer environments. One-to-one computer initiatives are quickly becoming an answer to the call of a technology-based world that wants students to be prepared to enter a global job market with constructivist 21st century skills.

The findings of this research study answered two questions. Research question 1 asked: Is there a significant difference in mean scores on end-of-year grade point averages comprised of semester grades in math, English, social studies, and science between middle school students

who participated in a one-to-one computing environment and those that did not? The data showed that a one-to-one computing environment had no significant difference on students' end-of-year grade point average means comprised of semester grades in math, English, social studies, and science. These results were consistent when comparing GPA means from the first year (2016–2017) of one-to-one computer implementation with GPA means from the year before (2015–2016) one-to-one computer implementation and when comparing the second year (2017–2018) of GPA means with the year before (2015–2016) one-to-one implementation. The study showed no significant difference of a one-to-one computer environment on students' end-of-year grade point average means.

Research question 2 asked: Is there a significant difference in mean scores on the Nevada Smarter Balanced Assessment Consortium (SBAC) Math and English Language Arts/Literacy Summative Test between middle school students who participated in a one-to-one computing environment and those that did not? The results of this research question were divided. Scores from the first year (2016–2017) of one-to-one implementation on the Math SBAC showed a significant difference when compared to the year before (2015–2016) one-to-one implementation. Scores from the second year (2017–2018) of one-to-one implementation on the Math SBAC showed no significant difference when compared to the year before (2015–2016) one-to-one implementation. Scores from both the first year (2016–2017) and second year (2017–2018) of one-to-one implementation on the English Language Arts/Literacy SBAC showed a significant difference when compared to the year before (2015–2016) one-to-one implementation.

The results of this research study are consistent with results from previous studies and provide significance to the need for further research into the effect one-to-one computing

environments have on academic achievement. The lack of significant results in the data relating to student achievement in the form of end-of-year student GPAs could and should be the springboard for future studies. Educational reform has not extinguished the reporting of grades as the final assessment of secondary courses. The majority of secondary schools across the country calculate some form of student grade point average on a 4.0 scale with honors classes being reported on a 4.5 or 5.0 scale to determine items such as class ranking, eligibility for sports, and entrance into college. Taking this into consideration, the need for more research to determine the effect one-to-one computer environments have on academic achievement, specifically student grade point averages, is not only vital but also imperative to successful evaluation of this 21st century driven pedagogy. If researchers do not add to the body of knowledge that exists and rely solely on the ambiguous results of the past studies, money may be wasted on expensive one-to-one computer implementations without receiving the desired results.

With any new pedagogical method comes a learning curve. One-to-one computing may only be 34 years into its introduction into pedagogy, but almost two generations of students have passed through public education in that amount of time. Some have had their academic achievement enhanced by a constructivist-driven learning environment with one-to-one devices, and some have not. Research into technology-enhanced curriculum taught and received in a one-to-one computing environment is of the essence. Finding out how technology fits into current pedagogical methods and how one-to-one devices can best enhance education for the future should be the reality that is created, not a dream that never comes to fruition, because education is a precious gift we provide our children to enhance their current and future societal living.

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Appendix A: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously- researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does “fraudulent” mean?

“Fraudulent” work is any material submitted for evaluation that is falsely or improperly presented as one’s own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate’s final work without full and complete documentation.

What is “unauthorized” assistance?

“Unauthorized assistance” refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another’s work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (Continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University–Portland Academic Integrity Policy during the development and writing of this dissertation.
2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*.

Amy Michelle Price

Digital Signature

Amy Michelle Price

Name (Typed)

8/16/19

Date