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Students to Computer Ratio, Socioeconomic Status, and Student Achievement

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Students to Computer Ratio, Socioeconomic Status, and Student Achievement

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by

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ABSTRACT

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The purpose of this study was to determine if there was a relationship between the students to computer ratio and 6th grade student achievement in Math and Reading during the 2013-2014 and 2014-2015 school years as compared by socioeconomic status at each of 562 schools in Tennessee. The independent variables in the study were the ratio of students to computer (low/middle/high), the change in ratio of students to computer from 2013-2014 to 2014-2015, and socioeconomic status (low/non-low). The dependent variables in the study were 6th grade mean Reading scores for 2014-2015, 6th grade mean Reading gain scores from 2013-2014 to 2014-2015, 6th grade mean Math scores for 2014-2015, and 6th grade mean Math gain scores from 2013-2014 to 2014-2015.

There was not a significant difference between the mean TCAP scores in Reading and Math and low, middle, or high technology schools. There was no correlation between the changes in ratios and TCAP Reading and Math scores. There was no significant difference between low, middle, and high technology schools as compared by their low or non-low SES. There was no significant difference in TCAP Reading or Math scores for low, middle, or high technology schools as compared by their low or non-low SES. There was no significant difference in the change in TCAP Reading and Math scores as compared by low, middle, or high technology and their low or non-low SES. There was no significant difference in TCAP Reading and Math achievement scores as compared by low, middle, or high technology in low SES schools. There

was no significant difference in TCAP Reading and Math achievement scores as compared by low, middle, or high technology in non-low SES schools.

DEDICATION

This work is dedicated to my parents, Gleason and Rhonda Watson. They have provided so many opportunities for me and offered their love and support through each one. Although I have not always succeeded at everything that has come my way, they both have always been beside me, encouraging me to get back on the bike even when I felt bruised and defeated. They have taught me the importance of education and have helped make my dreams a reality. Thank you for pushing me to be the best me and for your unconditional love along the way.

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TABLE OF CONTENTS

ABSTRACT…….2

DEDICATION…….4

ACKNOWLEDGEMENTS…….5

LIST OF TABLES…….9

LIST OF FIGURES…….10

Chapter

1. INTRODUCTION…….11

Statement of the Problem…….12

Research Questions…….12

Rationale…….13

Significance…….14

Definitions…….15

2. REVIEW OF RELATED LITERATURE…….17

How Students Learn…….17

Technology Benefits and Potential Drawbacks…….19

Barriers to Technology Implementation…….24

Resources…….24

Knowledge and Skills…….26

Institution…….27

Attitude and Beliefs…….27

Assessment and Subject Culture…….28

The Digital Divide…….29

Access……………………………………………………………………...30
Computer Use in the Home and at School.……..………………………………..33
Empowerment……………………………………………………………………35
Computers and Low Socioeconomic Status……………………………………………..37
Students to Computer Ratio…………………………………...…………………42
Chapter Summary………………………………………..……………………48
3. METHODOLOGY……………………………………………………………………50
Research Questions……………………………………………………………………50
Sample……………………………………………………………………………53
Instrumentation……………………………………………………………………..53
Data Collection……………………………………………………………………..54
Data Analysis………………………………………………………………………54
Limitations and Delimitations…………………………………………………...58
4. FINDINGS……………………………………………………………………………59
Research Question 1……………………………………………………………..59
Research Question 2……………………………………………………………..63
Research Question 3……………………………………………………………..66
Research Question 4……………………………………………………………..67
Research Question 5……………………………………………………………..71
Research Question 6……………………………………………………………..75
Research Question 7……………………………………………………………..79
Chapter Summary…………………………………………………………………..83
5. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS………84

Summary…………………………………………………………………………………...84

Conclusions………………………………………………………………………………84

Research Question 1……………………………………………………………..84

Research Question 2……………………………………………………………..85

Research Question 3……………………………………………………………..86

Research Question 4……………………………………………………………..86

Research Question 5……………………………………………………………..87

Research Question 6……………………………………………………………..87

Research Question 7……………………………………………………………..88

Recommendations for Practice…………………………………………………………..89

Recommendations for Future Research…………………………………………………90

REFERENCES……………………………………………………………………………..92

VITA………………………………………………………………………………...…….100

LIST OF TABLES

Table Page

1. Means and Standard Deviations for TCAP Mean Scores in Reading…………………...60

2. Means and Standard Deviations for TCAP Mean Scores in Math………………………62

3. Means and Standard Deviations for TCAP Mean Scores in Reading…………………...68

4. Means and Standard Deviations for TCAP Mean Scores in Math……………………....70

5. Means and Standard Deviations for the Change in TCAP Mean Scores in Reading……72

6. Means and Standard Deviations for TCAP Mean Scores in Math…………………………………………………………………………….……..74

7. Means and Standard Deviations for TCAP Mean Scores in Reading in Low SES Schools…………………………………………………………………………………...76

8. Means and Standard Deviations for TCAP Mean Scores in Math for Low SES Schools…………………………………………………………………………………...78

9. Means and Standard Deviations for TCAP Mean Scores in Reading for Non-Low SES Schools…………………………………………………………………………………...80

10. Means and Standard Deviations for TCAP Mean Scores in Math in Non-Low SES Schools…………………………………………………………………………………...82

LIST OF FIGURES

Figure Page

1. Distribution of TCAP Reading Means by Students to Computer Ratios……….……......61
2. Distributions of TCAP Math Means by Students to Computer Ratios……………..…....63
3. Change in the students to computer ratio and the change in TCAP Reading means…….64
4. Change in students to computer ratio and the change in TCAP Math means from 2013-2014 to 2014-2015……………………………………………………..……………..65
5. Distribution of Students to Computer Ratios for Low and Non-Low SES Schools…......67
6. Distributions of TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools………………………………………………………69
7. Distributions of TCAP Math Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools…………..……………………………………....71
8. Distributions of the Change in TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools………………………………………....73
9. Distributions of the Change in TCAP Math Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools…………………………..………..…75
10. Distributions of TCAP Reading Mean Scores by Student to Computer Ratio for Low SES Schools……………………………………………………………………………...77
11. Distributions of TCAP Math Mean Scores by Students to Computer Ratios for Low SES Schools……………………………………………………………………………...79
12. Distributions of TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES Schools………………………………………………………...………81
13. Distributions of TCAP Math Mean Scores by Students to Computer Ratios for Non-Low SES Schools………………………………...…………………………..…83

CHAPTER 1

INTRODUCTION

This dissertation was a quantitative study on the relationship of the students to computer ratio on student achievement for 6th grade students in Tennessee. Technology has often been viewed as a method of educational reform (Papert, 1993). When it comes to initiating positive change on student learning, school leaders must decide where to put their money, and technology is often proximal to this decision. Technology is both beneficial and necessary in preparing students for the future (Chung, 2002). An often asked question is whether increasing the number of devices available to students, positively supports academic achievement or has any significant impact at all. As educational leaders consider purchasing more technological devices for students, it is necessary to consider whether or not the cost is worth the benefit. Since the implementation of *No Child Left Behind* and the more recent enactment of the *Race to the Top* initiative, accountability has been at the forefront of the minds of educational leaders (Smith, 2012). State leaders hold administrators and teachers accountable for both student aggregate scores and subgroup scores. School leaders are tasked with the job of ensuring they are closing the gaps of each subgroup, which includes economically disadvantaged students. According to the National Center for Educational Statistics (2016b), 49.6% of students in the United States qualified for free or reduced lunch during the 2011 to 2012 school year, which classified them as economically disadvantaged. Some researchers have confirmed the use of technology as having positive impacts on student achievement (Dunleavy & Heinecke, 2007; Smith, 2012; Ward, Finley, Keil, & Clay, 2013), including economically disadvantaged students (Chung, 2002; DeGenarro, 2010), while other researchers have indicated technology has little to no impact on achievement (Angrist & Lavy, 2002; Leuven, Lindahl, Oosterbeek, & Webbink, 2004; Warschauer, Knobel & Stone, 2004).

Statement of the Problem

Because students spend extensive amounts of time engaged in technology, technology use in classrooms has been expressed as a way to not only engage students (Hicks, 2011) but better prepare them for the future (Celano & Neuman, 2010; Ottenbriet-Leftwich et al., 2010). In order to develop adequate computer literacy skills, students must have access to computer resources in the classroom (Obama, 2013), which is why many school leaders have aimed to increase the number of computers in schools (Dunleavy & Heinecke, 2007; Smith, 2012). Many hope that providing greater access to technology in schools can help to close some achievement gaps (Cheema & Zhang, 2013; Zheng, Warschauer, & Farkus, 2013), yet some researchers question if increased technology use impacts student learning at all (Angrist & Lavy, 2002; Warschauer, Knobel, & Stone, 2004). Additional studies are needed to determine the impact increased technology may have on student achievement. Therefore, the purpose of this quantitative study was to examine the relationship between the students to computer ratio and 6th grade student achievement in Math and Reading as compared by socioeconomic status at each of 562 schools in Tennessee. Data were gathered from two school years beginning in 2013 and ending in 2015.

Research Questions

Seven research questions and the associated null hypotheses were created and guided the research for this study. The questions focus on student achievement and the relationship between the students to computer ratio in low and non-low SES schools.

1. Is there a significant difference in mean student achievement during the 2014-2015 school year as compared by the ratio of students to computer?
2. Is there a significant relationship between the change in ratio of students to computer and the change in the mean student achievement scores from 2013-2014 to 2014-2015?
3. Is there a significant difference between the ratio of students to computer and school socioeconomic status during the 2014-2015 school year?
4. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by ratio of students to computer and the school socioeconomic status?
5. Is there a significant difference in the change in mean student achievement scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and the school socioeconomic status?
6. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools?
7. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer and non-low socioeconomic schools?

Rationale

Even though educational leaders in states and school systems are making a conscious effort to increase technology in the classroom, it is uncertain if the increased amount of technology can be connected to increases in student achievement. Inequities among students can impact student learning and achievement (Cheema & Zhang, 2013). The use of technology has the potential to close gaps caused by inequities such as socioeconomic status (Zheng, Warschauer, & Farkus, 2013).

Computers alone are not the answer to solving the issues of inequity (Warschauer, Knobel, & Stone, 2004). However, when implemented effectively, technology can make a difference in student achievement (Chung, 2002; DeGennaro, 2010; Smith, 2012). Putting computers into the hands of low socioeconomic students is the first step to eliminating technology inequities; however, further research must be conducted to determine whether increasing technology, in terms of quantity, has a significant relationship to increases in student achievement (Warschauer et al., 2004). Because studies on student use of technology have had mixed results (e.g. Chung, 2002; Dunleavy & Heinecke, 2007; Smith, 2012), it is necessary to continue to study technology and its impact on students across the United States. This study will add to the growing body of knowledge as it relates to increased technology implementation and student achievement. Because the sample is representative of the state of Tennessee, results of this study may be generalized to other populations.

Significance

This study was an analysis of the relationship between 6th grade student achievement scores and the ratio of students to computer as compared by school socioeconomic status in middle schools across Tennessee. Several researchers (Cheema & Zhang, 2013; Goolsbee & Guryan, 2002; Warshcauer, Knobel, & Stone, 2004) have examined the relationship of technology in schools and achievement with mixed results. Chung (2002) indicated no significant relationship between the ratio of students to computer and achievement. However, when using SES as a factor, low SES schools with high or middle technology levels performed better in math and reading than schools with low technology. The findings of this study will add to the body of research surrounding the relationship between the ratio of students to computer and student achievement. It will also provide a framework for district leaders, administrators, and teachers to develop strategies addressing how computer usage may impact student achievement. The findings of this study may also help school leaders plan for future resource allocation regarding technology funding.

Definitions

For the purpose of this study, the following terms are defined:

1. High technology school: a school with an average students to computer ratio of 2:1 or 1:1.
2. Low Socioeconomic School: a school with a high number of low socioeconomic students, in which 75%-100% of students are eligible for free reduced lunch (NCES, 2016a).
3. Low Technology School: a school with an average students to computer ratio of 6:1 or higher.
4. Middle Technology School: a school with an average students to computer ratio of 3:1, 4:1, or 5:1.
5. Non-low socioeconomic school: a school with a low to average number of low socioeconomic students; 0-74% of students are eligible for free reduced lunch (NCES, 2016a).
6. Socioeconomic Status (SES): status that is defined by the percentage of students eligible for free or reduced lunch. (National Assessment of Educational Progress, 2015).

7. Students to computer ratio: the number of students to each available student device at each school (Chung, 2002). This does not include teacher devices.
8. Tennessee Comprehensive Assessment Program (TCAP): a standardized, norm-referenced test given to students grades 3-8. This test assesses student understanding of the Tennessee Academic Standards in the areas of Reading/Language Arts, Mathematics, Social Studies, and Science (Tennessee Department of Education, 2017b).

CHAPTER 2

REVIEW OF RELATED LITERATURE

President Obama spoke on the increasingly important topic of technology in education in an attempt to foster the concept of digital learning. He stated "…[I]n an age when the world's information is just a click away, it demands that we bring our schools and libraries into the 21st century. We can't be stuck in the 19th century when we're living in a 21st century economy" (Obama, 2013, par. 13). President Obama's statement indicates that technology in schools is essential to preparing students to be successful in an evolving economy. In a technology-dependent society, the ability to use technology is of utmost importance. Furthermore, implementing technology in the classroom has often been expressed as a way to ensure students are prepared for the future (Celano & Neuman, 2010; Ottenbriet-Leftwich et al., 2010).

As educators work to keep American students globally competitive, use of technology is an increasingly important skill. Educational leaders in competing countries continue to intentionally invest in their technology resources which is what is required of the United States in order to compete in a global economy (Obama, 2013). Information and Communications Technology (ICT) is a hot topic in education because schools have been given the task of preparing students to be productive citizens (Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008). It is true that while schools were created and developed during a time before technology, schools today must evolve in order to compete in a connected world (Obama, 2013).

How Students Learn

Technology is becoming a greater part of everyday life (Wighting, 2006). Prensky (2001) claims that increased technology use for students correlates to the difference in the way students learn. He claims that students today process information differently (Prensky, 2001). Researchers often refer to school age children as digital natives meaning they have been born into a world where the impact of technology has already been established (Hicks, 2011; Morgan, 2014; Prensky, 2001). Because students use technology so extensively, they learn more when utilizing technology in learning activities (Hicks, 2011).

Prensky (2001) refers to teachers and anyone who is not classified as a digital native as a *digital immigrant* (p. 1). If digital proficiency can be compared to learning a foreign language, Prensky indicates that language learned later in life activates a different part of the brain. Digital immigrants have been raised differently and are now having to learn the digital language of digital natives. Brain structures can ultimately be affected by new and different stimulations. Neuroplasticity, the brain's ability to continually restructure itself throughout one's life, is why people of different cultures can actually think differently from one another. Prensky concludes that students today have a different set of cognitive skills than did children in prior generations. They literally think differently because of their extensive technology use.

In a similar way, Smith (2013) uses Evgeny Morozov's language to describe the older generations, namely many current teachers, as *digital captives* (p.33), meaning they see technology only as something to aid them in their lives by means of mastering certain programs and skills. Instead, he claims teachers must become *digital renegades* (p. 33) who are able to critically determine ways technology can transform learning by providing unique experiences for students in the classroom. Using technology with the mindset of a digital captive does not appeal to students because it does not realistically relate to real world uses of technology. The real world is not just about learning to use a keyboard and type documents into a word processor (Smith, 2013). Therefore, teachers must connect with students in a way other than the traditional methods used in the past (Prensky, 2001). Teachers must take time to understand how differently students learn today (Prensky, 2001) and apply that to technology use in the classroom (Smith, 2013).

Technology Benefits and Potential Drawbacks

There is little doubt that technology can enrich learning (Hicks, 2011). Because it can both motivate and engage students, school leaders view technology as an invaluable tool for students to use both inside and outside of the classroom. This belief has resulted in millions of dollars spent to acquire more technology in schools but not just for teacher use (Barnett, 2001). Instead, placing technology directly in the hands of the students is believed to have an even greater impact on student learning (Celano & Neuman, 2010). While some researchers like Sana, Weston, and Cepeda (2013) and Taneja, Fiore, and Fischer (2014) question the overall benefits of technology, others insist that technology use is beneficial in the classroom and to the students themselves (Maninger & Holden, 2009; Passey, Rogers, Machell, & McHugh, 2004).

Students are more engaged and involved in their learning when technology plays a role (Lowther, Ross, & Morrison, 2003; Maninger & Holden, 2009; Passey et al., 2004; Ward et al., 2013; Wighting, 2006). Students enjoy using computers in their learning, and when they enjoy learning, they are more motivated and engaged (Ottenbreit-Leftwich et al., 2010; Passey et al., 2004; Wighting, 2006). Passey et al. 2004 indicate motivation levels can shift for a student throughout his education due to multiple sources and experiences including cultural, social, emotional, and behavioral sources. According to this study, both primary and secondary students tend to have positive motivational impacts when they encountered with ICT, which included computers and laptops. Therefore, this indicates that being able to use the Internet and other software motivates students. Visual aspects of ICT, the ease of use, and the neatness in presentation are all factors that motivate students when using ICT (Passey et al., 2004).

The ability to use ICT resources allows students greater access to knowledge and information, which aids in understanding hard-to-grasp concepts. Having a visual, virtual tour, or 3D diagram can bring life to a lesson that would not be possible without technology (Ottenbreit-Leftwich et al., 2010). In the same way, using computers for activities like blogging can make students more excited about writing (De Abreu, 2010; Passey et al., 2004). Students are better able to problem solve and work more effectively using technology because they have many more resources right at their fingertips (Lowther, Ross, & Morrison, 2003; Maninger & Holden, 2009; Passey et al., 2004). Computers in general allow students to edit their work more easily which results in enhanced and more creative writing, appearance, presentation, and all around better work (Lowther, Ross, & Morrison, 2003; Passey et al., 2004). Technology has the power to increase comprehension and promote higher order thinking (Ottenbreit-Leftwich et al., 2010).

Use of computers can help create a community of teamwork as students collaborate on projects and other activities (Maninger & Holden, 2009; Schwarz, 2012; Wighting, 2006). Computers make it easier for students to learn from each other through blogs, wikis, podcasting, and social networking sites (Lee & McLoughlin 2007). Students work together more often when using technology (Lowther et al., 2003; Passey et al., 2004), which includes taking the initiative to help peers with hardware problems without being asked (Maninger & Holden, 2009). When students feel a relatedness toward others, they believe that they are able to connect well with others and feel accepted by their peers (Stroet, Opdenakker, & Minaert, 2015). Students can benefit from the sense of community that using computers in the classroom can foster as they build on their learning both independently and collaboratively (Wighting, 2006).

Teachers can also use technology to create a more constructivist learning environment as teachers do not just lecture from the front of the room, but instead guide students in their own learning process (Donovan, Hartley, & Strudler, 2007; Lowther et al., 2003; Maninger & Holden, 2009). Students feel they are able to take greater command of their learning through the use of computers compared to solely using textbooks (Wighting, 2006). Teachers who foster a constructivist environment are able to better personalize learning experiences for students (Passey et al., 2004; Ward et al., 2013). This is especially true for students who struggle in a regular classroom environment. Now with individualized programs like Khan Academy, teachers are changing the way they teach. Instead of being able to offer a lesson taught in only one way, teachers can individualize instruction for students with specific learning gaps. The goal of personalized learning programs such as Khan Academy is that they have the potential to give all students equal opportunity to succeed (Stegmeir, 2015). Furthermore, when teachers use computers in unique ways, students can overcome their individual academic struggles and are subsequently more likely to excel in their learning (Passey et al., 2004).

Teachers cannot deny the many benefits that technology not only provides for the students but also for the teachers themselves (Maninger & Holden, 2009; Passey et al., 2004). Although teachers are often hesitant when having to learn new information involving technology, in one study, teachers felt relief when their students had access to the Internet because it relieved the pressure of having to know it all (Maninger & Holden, 2009, p.14). Teachers indicate that another benefit to increased technology is a greater access to resources, and this can improve instruction and their understanding of the content area (Passey et al., 2004; Perrota, 2013). Teachers also believe it makes their lives easier by helping them raise learning standards and allows them to use different teaching methods in the classroom. Teachers are better able to help students with learning difficulties when students can use technology. Teachers are also able to improve their own classroom management as technology makes it easier to communicate with students and parents and grade assignments (Maninger & Holden, 2009).

Society gains benefits from technology use in schools. Mossberger, Tolbert, and Stansberry (2003) claim that technology not only benefits the individual by allowing that individual to acquire necessary skills for the workforce, but it also aids society as a whole by allowing for greater global competition. A workforce that is knowledgeable in current technologies is more productive in a technological world. The National Council of Teachers of English and the International Reading Association have even added specific student standards related to technology preparation because of the increased importance of technology in student learning today (Morgan, 2014). Technology plays an important role in moving a democratic society forward by offering it the knowledge to become more involved in the political arena (DiMaggio & Hargittai, 2001). It is evident that technology plays an important role in young people's lives even if Internet access is limited (Blanchard, Metcalf, Degney, Herrman, & Burns, 2008).

Belo (2012) discusses the potential, positive impacts technology can have on students, especially those who do not have computer or internet access at home. However, Belo also claims that even though these tools have the ability to increase test scores and improve learning, they also have the ability to cause more of a distraction for students because of the access to games, videos, and chat opportunities. In his study on the effects of broadband internet on student achievement, Belo collected data on broadband use and student grades from all middle schools in Portugal between the time the Internet was introduced school wide in 2005 to 2009. Usage increased dramatically over the four-year period. The findings indicate that ninth grade average exam scores increased from 2005 to 2009, which suggest positive impacts from increased computer and internet usage. The study also suggests that computer and internet access can have a negative impact on student performance. During this four-year period, there was a 0.97 drop in standard deviation in grades in middle schools across the country, which could be a result of distracted students. The researcher also suggests a greater adverse effect on boys compared to girls.

Although teachers report that students have better behavior when technology is in use (Passey et al., 2004), Taneja et al. (2014) claim that technology can be a distraction because students spend time engaging in other activities on their computers during designated learning times. Prensky (2001) claims that digital natives are able to multitask effectively, but Sana et al. (2013) argue that what students often view as mindless multitasking can still negatively impact comprehension of learning material. Students misuse the computers more often when they feel the classroom environment makes it easy for them to do so. In turn, when their friends are misusing computers, they are more likely to misuse computers (Taneja et al., 2014). If students are uninterested in the class or topics being discussed, they are more likely to misuse their computers (Taneja et al., 2014). However, students in a more structured environment tend to work quickly and stay on task during lessons involving technology more often than students in a less structured environment (Ward et al., 2013). Students feel most competent when there are clear expectations and structures in the classroom for their learning (Stroet et al., 2015). Still, teachers and students claim that technology can hold students’ interests. In order for ICT use to be most effective in engaging students, teachers must focus technology use more on the process of learning rather than completing assigned tasks (Passey et al., 2004).

Barriers to Technology Implementation

According to Attewell (2001), "Schools find it difficult to fulfill their current educational and social mandates, let alone embrace a visionary new one" (p. 254). Adding technology to the mix may seem more like a burden than a benefit at times. Hew and Brush (2007) identified six main categories for the barriers to technology use in the classroom: resources, knowledge and skills, institution, attitudes and beliefs, assessment, and subject culture.

Resources

When it comes to accessing technology resources, some teachers have very few resources available while other teachers have many resources. Teachers report that quantity of hardware and access is important to motivational factors (Passey et al., 2004). One challenge for increasing this quantity and improving technology in schools is allocating appropriate funding toward technology resources (Barnett, 2001; Ward et al., 2013). There is often a lack of funds designated in the budget for technology resources. In fact, some district leaders are forced to cut other areas such as staffing to afford technology (Scwharz, 2012). Though many leaders may be attempting to increase technology purchases, the high cost and the fear of maintaining devices frequently prevents system administrators from purchasing more technology (Ward et al., 2013). Implementing large amounts of technology takes time, effort, and focused planning with financial investment (Barnett, 2001; Donovan, Hartley, & Strudler, 2007; Maninger & Holden, 2009). The continued cost to sustain technology has teachers worried about investing their time into technology itself. When teachers are unsure whether a technology will remain, they are less likely to devote time to changing their lessons or creating new lessons based around the technology. Teachers do not want to put time into making changes if the technology will be gone the following year (Donovan, Hartley, & Strudler, 2007). Some school leaders feel that they do not have the financial ability to provide more technology to students in the classroom, yet the lowered cost of laptops and tablets has allowed other system leaders to provide students with more computers (Maninger & Holden, 2009). School leaders, teachers, and students in districts like Mooresville School District in North Carolina have seen the benefit of their technology investment by an increased graduation rate within three years of 1:1 laptop implementation and an increase in student proficiency levels all the while spending less money per student than one hundred other school districts in North Carolina (Schwarz, 2012). Although school leaders may increase technology, acquiring and maintaining technology resources remain a concern.

Hew and Brush (2007) and Hechter and Vermette (2013) identify the resource barrier as also including a lack of time to use resources, a lack of technical support, and a lack of actual access to available technology. Warschauer, Knobel, and Stone (2004) indicated that low SES schools had difficulty planning and using technology because of the lack of technology support, whereas high SES schools deliberately planned more professional development, making teachers more comfortable in using and relying on technology. Some of the biggest concerns for administrators were making sure teachers had the support needed to implement technology and making sure resources would be available to maintain the initiative in the future (Donovan, Hartley, & Strudler, 2007). Teachers must have confidence that technology will not fail in order to use it consistently and to take instructional risks that could lead to progressive teaching (Passey et al., 2004). These resource barriers must be taken into consideration for technology to have the greatest impact.

Knowledge and Skills

The biggest obstacle to implementing technology expressed by teachers is their lack of knowledge and skills in how to use technology in the classroom (Donovan, Hartley, & Strudler, 2007; Scherer, Siddiq, & Teo, 2014). Many veteran teachers did not have technology when they were growing up, yet they are being expected to use it regularly in their classrooms (Hicks, 2011). This idea contributes to why they feel they are not proficient enough in their technology skills to use the technology effectively (Hechter & Vermette, 2013; Hew & Brush, 2007; Hicks, 2011; Scherer, Siddiq, & Teo, 2014). Fear keeps teachers from using technology to its fullest in the classroom. Teachers do not only fear using computers, but fear the information available to students on the Internet (De Abreu, 2010). This, unfortunately, results in teachers using technology in ways that are immediately useful like checking email and taking attendance while avoiding student focused activities such as creating technologically interactive lessons (Attewell, 2001). Students and teachers are different in their understanding and proficiency in technology use, which according to Gu et al. (2013) is creating a new digital divide. Gu et al. (2013) researched K-12 schools in Shanghai, China, where 100% of schools have internet access and the students to computer ratio is 3:1. Gu indicated that students in Shanghai do not appear to use ICT more frequently or for longer periods of time than teachers do; however, students are still more confident in their technology use than teachers. In another study (Donovan, Hartley, & Strudler, 2007), teachers participating in a one to one implementation had greater concern for their own abilities to use technology than their students. Many teachers were apprehensive when it came to their own comfort level and proficiency with the technology, even more than with their comfort level and proficiency in using the computers to enhance instruction (Donovan, Hartley, & Strudler, 2007). Teachers are anxious when it comes to learning new technologies and implementing them on a regular basis, making knowledge and skill an obstacle for technology use.

Institution

Institutional barriers also have an impact on technology use in schools which directly relates to school leadership, structure, and planning (Hew & Brush, 2007). Institutional factors like culture and climate play key roles in shaping the way students and teachers view technology use within a school (Anderson, 2014). If school leaders have not developed a culture that places technology at the forefront, teachers will not feel confident in using technology, nor will they feel it necessary to incorporate technology into classroom instruction on a regular basis. School leaders play a vital part in overcoming institutional barriers. They must acknowledge and understand the worries of teachers when it comes to increasing technology (Donovan, Hartley, & Strudler, 2007). School leaders must also develop and sustain a team culture when it comes to technology implementation. As a team, administrators and teachers work collaboratively to successfully implement higher levels of technology use and understanding. Leaders must be dedicated to helping teachers brainstorm and problem solve to improve both teaching and learning through the use of technology (Maninger & Holden, 2009).

Attitude and Beliefs

Hew and Brush (2007) found teacher attitude and beliefs to be another common barrier. Teachers play the most important role in technology integration, and their positive or negative feelings toward technology determine whether or not it is incorporated (Hechter & Vermette, 2013; Hew & Brush, 2007; Scherer, Siddiq, & Teo, 2014). Additionally, their beliefs as to whether technology is valuable to learning can affect the level of integration. When teachers want to improve student learning and make technology work for their students, technology initiatives are more likely to be successful (Maninger & Holden, 2009). Perrota (2013) indicated that teachers had a higher perception of technology benefits when they believed they had more support from administration. In other words, a more supportive leadership resulted in a more positive attitude toward technology use and integration.

Assessment and Subject Culture

High stakes testing and subject culture have been identified as barriers to technology integration. The pressure to make gains in student learning deters teachers from focusing their time on incorporating new technology (Hew & Brush, 2007). With a heightened focus on standardized testing, it makes sense that teachers would not want to invest their time in developing lessons around technology. However, this idea may continue to change as schools implement more online evaluation programs (Hew & Brush, 2007). Hew and Brush identified subject culture as the least common yet still a prevalent obstacle to technology integration. Because certain subject areas have been taught for generations, particular norms have been developed which can obstruct the integration of new ideas. If teachers do not believe that technology fits with preconceived norms in their subject area, they will be less likely to welcome technology into their lesson (Hew & Brush, 2007). In addition, if they place higher value on instructional tools other than technology, they may be less likely to integrate technology in their subject area (Hechter & Vermette, 2013).

All of these barriers are connected to one another and can be eliminated within a school by developing and sustaining a shared vision of technology integration, which involves planning, overcoming the lack of technology resources, changing attitudes and beliefs about technology, holding professional development focused on technology, and refocusing assessments (Hew & Brush, 2007). Administrators and teachers must create a shared vision about technology (Hew & Brush, 2007), and this vision must guide technology-centered professional development (Hechter & Vermette, 2013). In addition, teachers must know what is expected of them, in the area of technology integration and use, for technology integration to happen more smoothly (Hew & Brush, 2007). For some schools, the largest barrier is simply a lack of technology, preventing teachers and students from using technology either consistently or effectively. Hew and Brush state that school leaders can overcome this issue by purchasing laptops for classrooms instead of creating computer labs or by having traveling laptop stations as opposed to utilizing resources for a fully equipped computer lab. Training students to help with technology maintenance helps to overcome the resource barrier (Maninger & Holden, 2009), in that it prevents schools from having to allocate funds for computer repair or additional technology staffing. Although struggles may arise for schools concerning technology, there are ways to address these struggles in order to maximize the potential of technology use, especially the use of computers (Barnett, 2001; Hew & Brush, 2007).

The Digital Divide

Regardless of the known barriers to technology implementation, it is evident that technology will not cease to exist in education. Perhaps this is why researchers have put extensive effort into studying the use of technology in classrooms and its effect on students, namely students of differing socioeconomic backgrounds. The term *digital divide* is used to describe the information gap between students with Internet access and those without (Attewell, 2001; Mossberger, Tolbert, & Stansberry). Hohlfeld et al. (2008) suggest three levels to the digital divide. The first level refers to access. The second level refers to how often and what technology is being used in the classroom. The third refers to the level of empowerment technology gives to students. Attewell (2001) and Carvin (2000) identify other factors involved in the digital divide—these include: how computers are used, student literacy levels, teacher use of computers, and community support. Carvin (2000) indicates that all of these factors are important in closing the digital divide; however, for the purpose of this study the three levels identified by Hohlfeld's et al. will be utilized to frame the literature on the digital divide.

Access

All students should have access to technology no matter their race, gender, ability, or socioeconomic background (Passey et al., 2004). However, for many students, access is limited or nonexistent. This digital divide represents the disparities in access, especially for minority students and students living in rural areas. Because of a lack of access to computers and Internet, educational reformists have coined the digital divide term (Attewell, 2001). Educational leaders have attempted to close this gap, first in regards to the Internet. The Telecommunications Act of 1996 helped guarantee that high speed internet services would be affordable and available in rural areas as well as in schools and libraries. In 2009, the Federal Communications Commission developed a plan, per the request of Congress, to guarantee that everyone in America had the capability to access broadband internet (Federal Communications Commission, 2016). More recently in 2013, President Obama joined with the Federal Communications Commission to ensure that 99% of American students would have high-speed Internet access in their schools by 2017. This initiative, known as the ConnectEd initiative, not only promises Internet connectivity but also promises adequate training for all teachers in using technology to improve student achievement (Obama, 2013).

As presidential administrations have continued to target the issue of unequal access because of its potential impact on digital literacy in America (Attewell, 2001), there has been a continued increase in the number of individuals who not only have a computer but are now able to access the Internet (Mossberger, Tolbert, & Stansberry, 2003). Adoption rates of technology in households have risen steadily since the late 1970's (United States Department of Commerce, 2014). Whether there is a school-aged student living in the home could be the deciding factor on whether a computer with Internet access exists in the home. Statistics indicate homes with children have a higher rate of adoption than those without children (Belo, 2012; US Department of Commerce, 2014). According to studies conducted by the Pew Research Center, in 2013 70% of Americans had broadband internet access in their homes (Zickuhr & Smith, 2013). Typically, low income households are much less likely to have a computer in the home than high income households. In homes where the annual income level is less than $25,000 a year, 49% have Internet access at home whereas 96% of homes where the income level is over $100,000 a year have Internet access. People cite their reasons for not having Internet as having no general need or interest, not being able to afford the cost, having no computer, or having an inadequate computer (US Department of Commerce, 2014).

Internet access is readily and freely available at local restaurants and libraries (Mossberger, Tolbert, & Stansberry, 2003), but Smartphones have changed even the need to access the Internet at these locations. When Smartphones are included in the internet access statistics, the access percentage increases from 70% to 80% (Zickuhr & Smith, 2013) In fact, with the introduction of smart phones, Internet connection disparities continue to be reduced.

Low income families, who may not have had Internet access or computers in the past, now have access through their mobile devices. The gap in cell phone adoption rates between rural and urban families is quickly decreasing guaranteeing access to Americans in different geographical settings. Nevertheless, people in rural areas tend to use the Internet on their phones less frequently than people in urban areas, which could be contributed to slower network speeds. Increased use of mobile devices for Internet access has also reduced the racial disparities in the digital divide. Although economic disparities still exist, mobile phone adoption has helped with the problem of Internet access (United States Department of Commerce, 2014).

Hohlfeld et al. (2008) include other aspects associated with access, such as access to hardware, software, and technology support. Without the appropriate applications, computers cannot be used to their full potential. Therefore, even if access to computers and internet is increasing in homes, access to software and applications that enhance 21st century skills may not. Therefore, ensuring access to current software and applications often becomes an educational expectation, supporting the role of schooling in technology access.

Although the concept of the digital divide is evident throughout literature (Attewell, 2001; Gu et al., 2013; Hohlfeld et al., 2008; Ritzhaupt et al., 2013), critics claim that the divide is about more than a lack of access (Carvin, 2000; DiMaggio & Hargitai 2001; Hall, 2006). Hall (2006) explains that conquering the divide takes more than just placing technology into the hands of students. For example, the increase in possession of mobile devices does not mean that users are taking advantage of advanced applications (United States Department of Commerce, 2014). In the same way, if students have technology and internet access in schools, a digital divide may still prevail due to a lack of benefits from actually using the Internet (DiMaggio & Hargittai, 2001). Smith (2013) agrees that the answer to giving all students the same advantage is not just providing more computers and greater access. Despite these critiques on providing technology and internet access, there is no doubt that the future of America will heavily rely on internet access (US Department of Commerce, 2014), so it is important that school leaders continue to allocate resources to ensure all students have access to technology.

Computer Use in the Home and at School

If access was not an issue, inequalities could continue to surface in other ways (Attewell, 2001). Hohlfeld et al. (2008) identifies the second issue with the digital divide as how computers are being used and how often. When it comes to using computers at home, computers are used more for leisure than for learning (Li & Ranieri, 2013). Li and Ranieri claim students use the Internet first and foremost for online chatting or fun and for playing online games at home. School leaders hope to provide a different technology agenda, though. Despite some students using computers more at home than at school (Gu, 2013), educators must continue to make efforts to provide quality time on computers. Schools must teach children about digital literacy in order for students to understand the educational possibilities of using technology inside and outside of school (Halverson & Smith, 2010). Halverson and Smith suggest two levels of technology in schools: technology for learning and technology for learners. Technology for learning refers to technology that is created to meet certain learning objectives. These technologies are teacher directed. Technology for learning is designed to work for any student at any level. They require little from the learner as they are cookie-cutter-type programs that guide learners and assess their learning. Conversely, technology for learners refers to the variety of options learners can demonstrate that they have achieved certain goals. In this case, the learners choose the means in which to show their learning. Therefore, the learner can take charge of his or her own learning by researching, browsing, and participating in his or her own learning outcomes (Halverson & Smith, 2010).

Halverson and Smith (2010) argue that the integration of technology in schools has not met the goals of original technology enthusiasts, nor has it increased student access to new learning opportunities. They claim technology has merely extended learning that was already taking place instead of creating new opportunities for students to learn. The technology revolution has taken place outside of schools rather than in schools. Nonetheless, students today find more value in technology based learning compared to learning in traditional classroom settings (Lee & McLoughlin, 2007). Therefore, teachers must develop varied, higher order technology-oriented activities, which help learners use technology more effectively instead of using it for drill and practice or games (Celano & Neuman, 2010; Li & Ranieri, 2013).

In his ConnectEd initiative, President Obama outlined his desire for teachers to have the available innovative resources to expand learning while also meeting new college and career-ready standards (Obama, 2013). However, to maximize the motivational impact of technology, ICT must be used for higher order learning processes, purposefully in different subject areas, and in connection with increasing student ownership of learning (Celano & Neuman, 2010; Halverson & Smith, 2010; Li & Ranieri, 2013). Teachers and students must also set higher, clearer expectations each time technology is used (Passey et al., 2004). Providing access is significant to demolishing the digital divide, but how teachers choose to use technology in the classroom is key in guaranteeing its success.

Empowerment

The third level Hohlfeld et al. (2008) refer to is the level schools are allowing technology to empower students. Researchers agree that using technology could have the capability to empower students (De Abreu, 2010; Gamliel & Gabay, 2014; Lee & McLoughlin, 2007; Shank & Cotton, 2013), but that depends on the abilities of school leaders to fulfill the first two issues of the digital divide: providing access and using technology effectively (Hohlfeld et al., 2008). The more time students are able to spend on technology, the more confidence they will have, and the more likely they will feel empowered (Shank & Cotton, 2013). Online access provides tools that can empower students by encouraging collaboration (Lee & McLoughlin, 2007; Lowther, Ross, & Morrison, 2003; Schwarz, 2012), increasing access to resources, and allowing students to share information (Lee & McLoughlin, 2007). Engaging in online activities and allowing students to analyze online media for themselves, (De Abreu, 2010) can empower students to problem solve, which will impact students outside of the classroom (Shank & Cotton, 2013).

In order to empower students, teachers must feel empowered themselves when it comes to using technology in the classroom (De Abreu, 2010). Not only does this mean that teachers need to be confident in using technology themselves, but it also means teachers must be willing to relinquish control and trust students for technology-immersed education to work (Schwarz 2012). Lee and McLoughlin (2007) state, "Current views of knowledge regard the notion of an instructor-dominated classroom and curriculum as obsolete, and embrace learning environments where students take control of their own learning, make connections with peers, and produce new insights and ideas through inquiry" (p. 4). Technology allows teachers to individualize lessons, especially when students have access to computers or tablets. This type of learning allows for more autonomy and student choice (Gamliel & Gabay, 2014; Lee & McLoughlin

2007) because students can work at their own pace (Schwarz, 2012). Although autonomy is sometimes described as being independent and disconnected, it really refers to having a choice. Classroom environments that support autonomy and competence lead to higher levels of intrinsic motivation (Ryan & Deci, 2000). For example, giving students the choice to present information verbally to their peers or online in a monitored blog or chatroom (Schwarz, 2012), gives each student a chance to excel in a way that is comfortable for him or her while still proving mastery of a skill. When students are empowered to create their own learning experiences using online media, true learning and creativity come into play, and this should be the objective of learning (Lee & McLoughlin, 2007). Teachers must demonstrate appropriate uses of technology and provide students with a variety of outlets for them to have a choice in demonstrating their own learning. By finding ways to demonstrate their own learning, students are empowered to use technology in ways that are meaningful to them (Hohlfeld et al., 2008).

One technique of empowerment places students in the role of the teacher. Gamliel and Gabay (2014) indicate that students felt empowered due to how well they showed control and mastery over a given subject. This came about through the process of teaching, which had great influence on student empowerment. When children are given the role of the teacher and are able to teach others what they are learning about technology, they build confidence and autonomy. Digital natives find it easy to use technology on a regular basis unlike many of their teachers (Gamliel & Gabay, 2014; Prensky, 2001). Therefore, allowing students to teach and help others increases their level of empowerment. Some schools with increased technology have established student-led technology help groups, allowing students to assist in fixing computer problems (Maninger & Holden, 2009) This not only increases student responsibility, but it places the student in the role of the instructor (Gamliel & Gabay, 2014).

Hohlfeld’s et al. (2008) interpretation of the digital divide encompasses real issues for school leaders to consider in closing the ICT literacy gap. As school leaders continue to see it as their responsibility to provide equal opportunities for students, technology will be included. Increased technology aids society in closing the digital divide by providing equal access, allowing opportunities for computers to be used for higher order thinking, and empowering students with skills for the future.

Computers and Low Socioeconomic Status

Socioeconomic status is an important factor for determining academic achievement (Cheema & Zhang, 2013; Majoribanks, 1996). Inevitably, low SES predicts low achievement for students (Caldwell & Ginther, 1996). For years, legislators have attempted to target low SES schools and students through additional support and funding such as Title 1. However, these attempts, though they can be successful, have not eliminated the gap in achievement between high and low SES students (Caldwell & Ginther, 1996).

Caldwell and Ginther (1996) studied the learning styles of low socioeconomic status students who are low achieving compared to those who are high achieving. The researchers suggest instructional learning style is not a significant factor for math and reading achievement for low SES students who are low and high achievers. However, internal factors like motivation played a significant role in student achievement. Students with higher internal motivation tend to perform better academically, which indicates high motivation may offset some of the negative factors impacting students in low socioeconomic homes. This suggests that if teachers can promote internal motivation with tools such as technology, all low SES students have the potential to be high achieving (Caldwell & Ginther, 1996). Intrinsic motivation is difficult to cultivate in formal classroom settings, but the more independence and choice students have, the more likely teachers are able to cultivate this type of motivation (Passey et al., 2004). Therefore, increasing motivation requires teachers to give up some of their control (Caldwell & Ginther, 1996), which can happen when technology is implemented in the classroom. Caldwell and Ginther claim that there are some low SES students who are high achievers. They suggest learning styles are associated with this truth, meaning students with certain learning styles, no matter their SES status, learn better with traditional instructional methods. If this is true, the converse should be true as well: certain students, no matter their SES status can also learn better with more innovative instructional methods, such as those methods involving technology.

Some researchers of SES bring to question the term digital natives. As it is previously mentioned, this term is assigned to any adolescent living in the 21st century (Li & Ranieri, 2013; Prensky, 2001), yet this may not be so true of low SES students. Ownership and access have been identified as factors that intensify the digital divide issue especially for those in low income situations. Although access disparities are diminishing (United States Department of Commerce, 2014; Zickuhr & Smith, 2013), disadvantaged students are less likely to have access to computers at home, much less Internet access (Anderson, 2014). Passey et al. (2004) indicated student abilities to effectively use ICT are affected by socioeconomic levels relating to home access and experience using computers (Passey et al., 2004). It is true that smartphone technology is slightly closing the device gap, yet Anderson (2014) cautions that the activity on Smartphones may differ from activity on a computer. The focus of closing the digital divide may need to shift to the purpose of how technology is being used. Warschauer (2016) also warns that although some youth may use computers and Internet, their family members may not be proficient in computer use themselves which can affect computer mastery of adolescents living in the home. The kinds of computer experiences that children have are heavily dependent upon conditions in the home. Students in rural environments do not spend as much time on computers inside and outside of school, nor do they feel very skilled in their computer usage (Celano & Neuman, 2010; Li & Ranieri, 2013). The lack of guided computer use puts them behind on technology knowledge and proficiency (Celano & Neuman, 2010) in areas such as autonomy, skill, experience, and social support (DiMaggio & Hargittai, 2001).

Disadvantaged students need more time with technology in school in order to catch up and keep up with their higher income peers (Celano & Neuman, 2010). Ritzhaupt et al. (2013) indicates the idea of a digital divide among the three different variables in their study: gender, SES, and ethnicity. Those students considered part of the low SES group are considered less proficient ICT users than students of middle and high SES groups.

School leaders must ensure computer access at school for those disadvantaged students lacking ICT capabilities at home (Li & Ranieri, 2013). When computers are incorporated into classroom instruction for substantial amounts of time, the effects may be even greater for low SES students compared to their peers (Page, 2002). Page analyzed achievement scores of ten 3rd through 5th grade low SES classrooms using an experimental technology group and a control group. There was a significant positive difference in math achievement scores for the technology-enriched group compared to the control group. In addition, Page documented higher levels of student to student interaction in technology-enriched environments compared to their counterparts. Page suggests that technology can have a positive effect on low SES student achievement and can increase student led interactions.

The phrase "leveling the playing field" refers to closing the gaps of the digital divide by equalizing resources for all students (Smith, 2012). In the ConnectED press release, the Obama

Administration used this phrase as part of a promise to rural communities to increase quality technology resources and learning experiences (The White House, 2013). Although Internet access itself has increased, computers are not necessarily as readily available, especially in low SES schools (Attewell, 2001). Mason and Dodds (2005) point out that students in schools with inferior technology resources can receive an inferior education. For example, Hohlfeld et al. (2008) suggests that students who attend schools with an overall higher SES status tend to have access to better software packages indicating that these students may be better prepared for college and the workforce. Teachers in high SES schools reported using technology in their classrooms more frequently than low SES schools. Students in low SES schools use content delivery computer software more frequently than their high SES counterparts. In contrast, high SES students use more production software, which could be a result of teacher comfort level and at home computer use. The study indicates that high SES students are utilizing computers for higher order skills more often than low SES students.

Others studies (Celano & Neuman, 2010; Li & Ranieri, 2013) also suggest that computer use is much different for low SES students than high SES students. Low income students use computers more for entertainment whereas middle and upper-class students use it more for gathering information (Celano & Neuman, 2010). Li and Ranieri (2013) suggest that rural students are less likely to have digital access, Internet usage, social support, and confidence when it comes to navigating the digital world. Findings regarding internet usage at home compared to at school were consistent with other global studies in that students claim to use Internet more at home than at school. They suggest digital technology in schools is not moving as fast as the rate of technology use in the home. In addition, they caution that this could make integration of new technology or media in schools more difficult. Li and Ranieri also suggest educational background of parents can impact internet usage and capabilities of their children. In other words, though the actual gap in access is decreasing and more students are being exposed to the Internet, the quality of activities along with the content viewed may still be causing gaps among different students. In summary, what happens inside the home, regarding technology, can play a larger role than technology use at school.

Attewell (2000) and Levy, Navon, and Shapira (1991) also warn of how students could be using computers. Low SES students use computers mainly for drill and practice assignments while affluent students use computers for more creative and critical thinking tasks. Teachers in different schools emphasize different skills with students. In rural and migrant schools, technology is used more to prepare students for the workforce, where urban teachers emphasize the use of technology for higher order skills to prepare students for college (Li & Ranieri, 2013).

Few say that more technology will only increase the divide among low SES and high SES students. Hargittai (2010) aimed to gather a better understanding on whether the opportunity for Internet access leveled the playing field for young adults who are considered digital natives. According to Hargittai, women, students of low socioeconomic status, and Hispanic and African American students showed less Web know-how than other students. Students with better understanding of technology and Internet use tended to use the internet more frequently than their counterparts. Hargittai suggests students of higher socioeconomic status stand to benefit more from Internet use, therefore, exacerbating the level of inequality between certain groups of students.

Despite this harsh opinion, teachers who are working in more challenging schools believe technology can have greater benefits on all students including more engaged and independent learning (Perrota, 2013). They have seen increased confidence in lower level students because of

ICT use. Students believe that they can produce better work and attempt more difficult activities with the assistance of technology, and their parents agree (Passey et al., 2004). As school personnel continues to tackle this area of concern, technology continues to be used to close gaps and level the playing field for low SES students in particular (Smith, 2012).

Student to Computer Ratio

It is inevitable that students will have socioeconomic differences. However, if all students have access to computers during the school day, some of these differences can be avoided, especially when it comes to owning and being able to access an electronic device (Obama, 2013). No matter a student's economic background, technology levels the playing field (Obama, 2013; Smith, 2012).

Increasing the number of devices in schools has proven beneficial for several school districts (Chung, 2002; Schwarz, 2012). For example, Mooresville School District in Mooresville, North Carolina has seen huge success from moving its computer ratio to 1:1 in 2008. One to one technology refers to one device per student including both tablets and laptops. Since then, the district has drastically increased its graduation rate, improved test scores, and more importantly, positively changed instruction (Obama, 2013; Schwarz, 2012). Similarly, the Science Leadership Academy in Philadelphia, Pennsylvania was developed to help decrease high dropout rates in Philadelphia schools. Increasing technology at this particular school resulted in increased test scores and 97% of 2010 graduates immediately attending college upon graduation. Loris Elementary School in Loris, South Carolina also invested in increased devices for students grades 3 through 5, which improved the school's ranking in the state. Technology investments have proven to be so effective that this school hopes to continue to increase its technology availability for students (The White House, 2013).

Increasing the number of educational devices will lead to new opportunities for understanding and mastery (The White House, 2013). When students are limited by technology access, their potential to succeed is restricted by the resources in their individual schools. With Internet access, many opportunities are available for any child anywhere. Technology offers more opportunities for students to work at their own pace and for teachers to better work individually with students as well (The White House, 2013).

Chung (2002) suggests a relationship between the student to computer ratio and reading and math scores in low SES schools. Chung researched several high, middle, and low income schools analyzing the computer ratio and test results according to The Annual Pennsylvania System of School Assessment. The researcher specifically focused on 5th graders and their reading and math scores during the 2000-2001 school year. Chung found no significant difference in reading or math scores overall in relationship to the number of students to computer when looking at schools of varying socioeconomic status. However, when Chung compared schools of similar SES status, the research implied different results. This was most often true for low SES schools. When a low SES school had a greater number of computers, students performed better in math and Reading (Chung, 2002), indicating that disadvantaged students can benefit from computer use.

Mouza (2008) compared classes with different computer ratios in her study in an urban, low SES school in New York. Students in the study classes had a 1:1 laptop ratio while students in the comparison classes only had two computers for the entire class. Mouza indicated that teachers with a higher number of computers tended to use the computers for more challenging activities while the teachers with a lower number of computers used them for lower level activities. When students of both groups were surveyed on their attitudes toward computers, both groups emphasized the importance of computers and how they can aid in learning. However, the laptop group commented on how computers can be used for creativity and thinking whereas comparison students emphasized the computer as an informational resource. The laptop group demonstrated other positive results such as increased motivation in students and increased collaboration among students. Teachers of laptop groups suggested that students had improved academically in their writing and mathematics skills. However, comparison group teachers did not suggest that computers helped with academic improvements (Mouza, 2008).

The 1:1 student to computer ratio trend is growing across the United States (Maninger & Holden, 2009). The ability to maximize technology capabilities is highest when every child has equal, consistent access to a technology device. Decades ago, Papert (1993) predicted that once the student to computer ratio was 1:1, technology would have the chance to reach its full potential in the classroom. Yet, it was not until 2002 that the idea of 1:1 technology was implemented in the United States where the Maine Learning Technology Initiative provided laptops to every seventh and eighth grade student and teacher in the state (Zheng, Warschauer, & Farkus, 2013). Many hope that providing greater access to technology can help close some of the achievement gaps in schools (Cheema & Zhang, 2013; Zheng, Warschauer, & Farkus, 2013).

Though studies on the effects of 1:1 on achievement and the effects of 1:1 on disadvantaged students have mixed results, several school leaders have seen great success with this equal student to computer ratio (DeGennaro, 2010; Dunleavy & Heinecke, 2007). For example, DeGennaro (2010) discussed a low SES school in Massachusetts that, historically, has struggled in areas of student achievement, graduation, grades, and parent involvement. After implementing a 1:1 laptop initiative that offered courses to both students and parents, the school leaders and teachers saw overall improvements in education for disadvantaged students. Dunleavy and Heinecke (2007) obtained similar results on the benefit computer use can have on certain groups of students. They researched an at-risk middle school which had been progressively implementing 1:1 technology for four years to improve test scores and prepare students for a technological world. Researchers classified the students in the study as 60% free and reduced lunch while 87% of students were minorities. Because only one team per grade level implemented 1:1 technology at this school, Dunleavy and Heinecke (2007) were able to compare data of laptop users and non-laptop users. Dunleavy and Heinecke suggested a significant positive difference in science achievement of students participating in the 1:1 program compared to those who did not. However, there was no significant difference in math achievement for these same groups.

Smith (2012) studied whether the subgroup gaps of race, gender, and limited English proficiency (LEP) at one high school were positively affected by 1:1 technology three years into a 1:1 deployment initiative. According to Smith, there was no significant difference in Algebra I or English I EOC scores suggesting no evidence that achievement gaps are being closed by 1:1 technology. In addition, there appeared to be no significant impact on closing the achievement gap between limited English proficiency learners and non-limited English proficiency learners. However, the use of 1:1 technology did show a significant impact in regard to eliminating the achievement gap between males and females. Although the study did not suggest that gap closures were being reduced for the race and LEP subgroups, overall, students showed gains in test scores from before the digital conversion compared to after the digital conversion (Smith, 2012). This indicates that the subgroups still saw growth in Algebra and English scores as a result of the 1:1 conversion.

Even if every student does not have a device, there are still benefits to students using shared technology (Ward et al., 2013). Ward et al. conducted a study involving iPads and biology concepts. Students with the lowest levels of understanding prior to the iPad lesson had the greatest improvement in post test scores after participating in the iPad lesson. Every student did not have an iPad in his or her hands, yet students showed gains in their learning because they were interested and engaged in the lesson. In fact, students at all ability levels were anxious to be able to use iPads in another lesson.

Similarly, Machin et al. (2007) researched standardized test scores in England from the years 1999 to 2003 during which ICT funding was increased. Machin et al. indicates increased funding resulted in increased test scores in English and Science but not in Math in primary schools. Passey et al. (2004) indicate that increased use of ICT appears to increase student achievement as measured by grades in the schools. For example, 76 percent of students from the four schools studied earned A's, B's, and C's whereas the national average for these same grades was 54 percent. Though both the national and school average increased from 1999 to 2003, there seemed to be a greater increase in these schools that exemplified effective ICT implementation and use. Although it cannot be proven that the cause of this increase was ICT use alone, ICT could have played role in this change.

Some studies indicate negative or no effects on student performance with greater computer and Internet accessibility (Angrist & Lavy, 2002; Goolsbee & Guryan, 2002; Malamud & Pop-Eleches, 2011). According to Goolsbee and Guryan (2002), increased Internet and computer usage has no effect on standardized test scores. In a study on computer vouchers in

Romania, student achievement appeared to decline after more computers were introduced to students in this area (Malamud & Pop-Eleches, 2011). Leuven, Lindahl, Oosterbeek, and Webbink (2004) indicate that offering computer subsidies to disadvantaged schools does not suggest positive effects on student achievement in the Netherlands and could suggest negative effects in achievement, particularly for girls. Similarly, Angrist and Lavy (2002) conducted a study involving Israeli schools in which several schools acquired a significant increase in the number of computers introduced to each school. Angrist and Lavy suggest no significant impact on learning as measured by test scores of students involved in the program. Results of the study were mostly negative in regard to the impact though mostly not significant.

In a study on technology use of students from different socioeconomic backgrounds, Warschauer, Knobel, and Stone (2004) indicate that no matter the student, many teachers focused technology use on mastering the software or completing a task rather than mastering academic objectives. Teachers in this study struggled with effectively implementing technology into their daily lessons. Some complained that using technology with English Language Learners was difficult and ineffective for student learning because of the language barrier. Because of how the teachers in this study used existing technology, Warschauer et al. found little evidence to indicate that the use of technology in various low SES and high SES schools was closing inequity gaps. What is more important, according to Warshcauer et al., is the structure in which technology is implemented. This includes the how, why, and when of deployment and usage, which is why these researchers claim that careful planning in these areas can have a greater impact on the success of technology use.

Cheema and Zhang (2013) argue that because socioeconomic status has the greatest impact on achievement, the use of technology may or may not be able to bridge socioeconomic gaps in learning. Therefore, researchers imply that there is still so much to learn from studying the impacts of technology on students (Bebell & Kay, 2010; Cheema & Zhang, 2013; Page, 2002). Previous research suggests having a greater number of computers can have a significant impact on reading and math achievement (Chung, 2002). Still, there is little research on whether socioeconomic gaps can be diminished by greater computer implementation. Further research must be conducted to support or deny these findings and to determine what can best help all students.

Even with mixed findings on its benefits, technology continues to be placed into classrooms with the belief that it can make a positive difference in education. Millions of dollars have been spent on classroom technology (Page, 2002), yet the question is whether this addition proves to be a successful tool in improving student achievement.

Chapter Summary

Technology will continue to impact the world of education as leaders promote 21st century learning as necessary for the growth of a democratic society (Obama, 2013). If students today truly learn differently than those of the past (Hicks 2011; Prensky, 2001), technology could be the key to further student success. However, teachers play a vital role in technology implementation, making their beliefs about the relevance and impact of technology of utmost importance (Li & Ranier, 2013). Though some teachers do not use technology frequently enough or in a way that is beneficial to student growth (Hicks, 2011), others have found that technology has the potential to increase meaningful learning experiences for all students, including those of low-socioeconomic status (Hall, 2006). Teachers do not deny that increased technology use better prepares students for the future (Maninger & Holden, 2009; Ottenbreit-Leftwich et al., 2010), which is why it is crucial today for teachers to learn the language of digital natives and teach to them in this way (Prensky, 2001).

Placing technology in the hands of students can positively impact achievement (Celano & Neuman, 2010) as it keeps students more engaged and involved in their learning (Maninger & Holden, 2009; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Passey et al., 2004). This is particularly true for low socioeconomic students (Cheema & Zhang, 2013). Increasing the number of computers in schools gives educators the means to level the playing field, so all students have a chance to excel (Smith, 2012). When students have more opportunities to individually use computers, teachers are able to create a more student-centered, active learning environment (Lowther, Ross, & Morrison, 2003), which further validates the need to better understand how increasing computers in every classroom can impact learning.

CHAPTER 3

METHODOLOGY

Researchers have examined the relationship between computers and student achievement for low SES students (Chung, 2002; DeGennaro, 2010; Dunleavy & Heinecke, 2007; Mouza, 2008). It is difficult to understand the overall effect of technology on society much less in schools because technology is constantly improving and changing (Wighting, 2006). This could be why some research has mixed results (Cheema & Zhang, 2013; Goolsbee & Guryan, 2002; Warshcauer, Knobel, & Stone, 2004), stressing the need for continued study.

As school leaders continue to allocate funding toward technology, many will follow the trend of aiming for a lower student to computer ratio perhaps until every child has a computer in his or her hands. Central to this study was a focus on how the students to computer ratio may correlate with student achievement and SES. A quantitative, non-experimental, comparative analysis was conducted to determine if there was a significant difference between student achievement and the student to computer ratio as compared by school socioeconomic status associated with schools utilized in this research.

Research Questions

Seven research questions and the associated null hypotheses were created and guided the research for this study. The questions focus on student achievement and the relationship between the ratio of students to computers in low and non-low SES schools.

1. Is there a significant difference in mean student achievement during the 2014-2015 school year as compared by the ratio of students to computer?

H_01_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading during the 2014-2015 school year as compared by the ratio of students to computer.

H_01_2: There is not a significant difference in 6th graders' TCAP mean scores in Math during the 2014-2015 school year as compared by the ratio of students to computer.

2. Is there a significant relationship between the change in ratio of students to computer and the change in the mean student achievement scores from 2013-2014 to 2014-2015?

   H_02_1: There is not a significant relationship between the change in ratio of students to computer and the change in 6th graders' TCAP mean scores in Reading from 2013-2014 to 2014-2015?

   H_02_2: There is not a significant relationship between the change in ratio of students to computer and the change in 6th graders' TCAP mean scores in Math from 2013-2014 to 2014-2015?

3. Is there a significant difference between the ratio of students to computer and school socioeconomic status during the 2014-2015 school year?

   H_03_1: There is not a significant difference between the ratio of students to computer and school socioeconomic status.

4. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by ratio of students to computer and the school socioeconomic status?

   H_04_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by ratio of students to computer and school socioeconomic status.

H_04_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by ratio of students to computer and school socioeconomic status.

5. Is there a significant difference in the change in mean student achievement scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and the school socioeconomic status?

   H_05_1: There is not a significant difference between the change in 6th grade Reading mean scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and school socioeconomic status.

   H_05_2: There is not a significant difference between the change in 6th grade Math mean scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and school socioeconomic status.

6. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools?

   H_06_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools.

   H_06_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools.

7. Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer and non-low socioeconomic schools?

H_07_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by the ratio of students to computer and non-low school socioeconomic status.

H_07_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by the ratio of students to computer and non-low school socioeconomic status.

Sample

The researcher used a sample of the 6th grade population in the state of Tennessee. Over the past several years, the level of technology in schools has increased because of online testing procedures that were to be implemented during the 2015 to 2016 school year. As a result of changes in assessments required by the Tennessee Department of Education (TNDOE), students are required to have computer and internet access (Tennessee Department of Education, 2017a). Knowing this change was coming, school leaders have been forced to allocate more resources toward technology to meet TNDOE mandates. The average students to computer ratio was 15:1 during the 2013-2014 school year and 4.7:1 during the 2014-2015 school year. There are 633 schools in Tennessee with approximately 73,000 6th grade students. Only 562 schools had available TCAP data for both years of the study; therefore, 71 schools were eliminated from the study.

Instrumentation

The researcher used existing data for this study. Data concerning the amount of technology available in each school for the 2013-2014 and 2014-2015 school year were gathered from the Tennessee Online Ready report. The Tennessee Online report contains data on the number of available student devices in each school in the state. Student enrollment numbers, demographic information, and which schools fall into the low and non-low SES categories are all collected from the School Data Profile which can be found on the TDOE website.

The instrument used to measure academic achievement was the TCAP. For this study, TCAP scores for the sixth grade in the areas of Reading and Language Arts and Math were utilized. The test has been modified over the years to increase its validity. Students take the test in a monitored environment using pencil and paper. Student scores from 2013-2014 were recalculated in 2015 in order to obtain a more accurate comparison to School Growth Measures in 2014-2015.

Data Collection

The proposed study was approved by the East Tennessee State University Institutional Review Board (IRB). The Tennessee Online Readiness Survey results were then collected from the Tennessee Department of Education after filing an online data request. The School Data Profile was accessed by the researcher via the Tennessee Department of Education website in the public data access files. TCAP data from the 2013-2014 and 2014-2015 school years was gathered from the TVAAS public website. Because the data in this study are identifiable by school or grade level as a whole, data accessed or obtained are not linked to any individual. This ensures the anonymity and protection of individual students.

Data Analysis

The data for the ratio of students to computer in each school were sorted into three different subgroups based on the level of technology in the school: low, middle, and high.

Because the majority of schools fell into the middle category, schools were divided based on the average ratio. The high technology schools had a 1:1 or 2:1 students to computer ratio, middle technology schools had a 3:1, 4:1, or 5:1 students to computer ratio, and the low technology schools had a 6:1 or higher students to computer ratio. The data for the SES of each school were sorted into two different subgroups (low and non-low socioeconomic status) based on the percentage of free and reduced lunch eligibility. These levels were determined using parameters established by The National Center of Educational Statistics. *The Condition of Schools 2016* report identifies high poverty schools as those with 75%-100% of students eligible for free reduced lunch (NCES, 2016a). Therefore, this parameter was used to identify schools that fall into the low SES subgroup. The independent variables in the study were the ratio of students to computer (low/middle/high), the change in students to computer ratio, and SES (low/non-low). The dependent variables in the study were 6th grade mean Reading scores for 2014-2015, 6th grade mean Reading gain scores from 2013-2014 to 2014-2015, 6th grade mean Math scores for 2014-2015, and 6th grade mean Math gain scores from 2013-2014 to 2014-2015. The researcher referred to the Normal Curve Equivalent (NCE) scores for this exam in both the areas of Reading and Language Arts and Math.

Once the data collection was completed, the data were analyzed using Statistical Program for Social Sciences (SPSS) software. Types of data analyses were guided by the research questions in this study. To address Research Question 1 the researcher analyzed data to determine if there was a significant difference in mean student achievement scores as compared by the students to computer ratio in low, middle, or high technology schools. Null hypothesis 1 was addressed by comparing school technology levels as measured by 6th grade mean reading scores. Null hypothesis 2 was addressed by comparing school technology levels as measured by

6th grade mean math scores. To determine if there were significant differences, a one-way analysis of variance (ANOVA) was conducted for each hypothesis.

To address Research question 2 the researcher analyzed data to determine if there was a significant relationship in the change in schools' ratio of students to computer and their change in mean TCAP scores from the 2013-2014 to the 2014-2015 school year. Null hypothesis 2_1 was addressed by comparing the change in ratio of students to computer as measured by the difference in mean TCAP reading scores from the 2013-2014 to the 2014-2015 school year. Null hypothesis 2_2 was addressed by comparing the change in ratio of students to computer as measured by the difference in mean TCAP math scores from the 2013-2014 to the 2014-2015 school year. A Pearson Correlation was conducted for each hypothesis to determine if there were any significant relationships.

To address Research Question 3 the researcher analyzed data to determine if there was any significant difference between low, middle, and high technology schools as compared by socioeconomic status. The null hypothesis was addressed by comparing schools' ratio of students to computer to their low socioeconomic status or non-low socioeconomic statuses. An independent t-test was used to determine if there was a significant difference.

To address Research Question 4 the researcher analyzed data to determine if there was any significant difference in mean TCAP scores for students in low, middle, and high technology schools as compared by their low or non-low socioeconomic status. Null hypothesis 4_1 was addressed by comparing the ratio of students to computer for low or non-low socioeconomic schools as measured by the mean TCAP reading scores for the 2014-2015 school year. Null hypothesis 4_2 was addressed by comparing the ratio of students to computer for low or non-low socioeconomic schools as measured by the mean TCAP math scores for the 2014-2015 school year. A two-way analysis of variance (ANOVA) was used for each hypothesis to determine if there were any significant differences.

To address Research Question 5 the researcher analyzed data to determine if there was a significant relationship in the change in mean TCAP scores from the 2013-2014 to the 2014-2015 school year as compared by the ratio of students to computer and the school socioeconomic status. Null hypothesis 5_1 was addressed by comparing the ratio of students to computer and school SES as measured by the change in mean TCAP reading scores from the 2013-2014 to the 2014-2015 school year. Null hypothesis 5_2 was addressed by comparing the ratio of students to computer and school SES as measured by the change in mean TCAP reading scores from the 2013-2014 to the 2014-2015 school year. A two-way analysis of variance (ANOVA) was used for each hypothesis to determine if there were any significant differences.

To address Research Question 6 the researcher analyzed data to determine if there was a significant difference in mean student achievement scores as compared by in low, middle, or high technology schools for low SES schools. Null hypothesis 1 was addressed by comparing school technology levels as measured by 6th grade mean Reading scores. Null hypothesis 2 was addressed by comparing school technology levels as measured by 6th grade mean Math scores. To determine if there were significant differences, a one-way analysis of variance (ANOVA) was conducted for each hypothesis.

To address Research Question 7 the researcher analyzed data to determine if there was a significant difference in mean student achievement scores as compared by in low, middle, or high technology schools for non-low SES schools. Null hypothesis 1 was addressed by comparing school technology levels as measured by 6th grade mean Reading scores. Null hypothesis 2 was addressed by comparing school technology levels as measured by 6th grade mean Math scores. To determine if there were significant differences, a one-way analysis of variance (ANOVA) was conducted for each hypothesis. All data were analyzed at the level of .05 significance.

Limitations and Delimitations

The accuracy of the Tennessee Online Readiness Survey is limited to the accuracy and honesty of the respondents. The computer number data was collected by the state through a third party. Personnel from individual schools were required to submit computer numbers for their respective schools. In addition, the researcher was unable to control for the amount of time students spent using computers in Reading and Math during the 2013-2014 and 2014-2015 school years. The study is also limited to schools only in Tennessee.

The study was delimited to include only sixth grade achievement and did not include an analysis of other grade levels. The researcher chose to follow two different groups of sixth graders during two different school years instead of following a cohort of students. This decision was made based on the ability to gather data. Gathering data on a cohort of this size would have been difficult. This means that other factors could impact changes in student achievement besides a change in the students to computer ratio. The study was also delimited to only include achievement data in the subject areas of Reading and Math.

CHAPTER 4

FINDINGS

The purpose of this study was to determine if there is a relationship between the students to computer ratio and 6th grade student achievement in math and reading during the 2013-2014 and 2014-2015 school years as compared by school socioeconomic status. The 562 schools included in this study serve about 304,000 students. No data were included for schools without reported achievement scores, school computer numbers, or percentage of economically disadvantaged students.

Data were presented and analyzed to answer seven research questions and 13 null hypotheses. Data were collected for each school containing a 6th grade during the 2013-2014 and 2014-2015 school years. Data were retrieved from the School Data Profile and the Tennessee Online Readiness Counts Survey by the researcher via the Tennessee Department of Education and the TVAAS public data websites.

Research Question 1

Is there a significant difference in mean student achievement during the 2014-2015 school year as compared by the ratio of students to computer?

H_01_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading during the 2014-2015 school year as compared by the ratio of students to computer.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Reading scores during the 2014-2015 school year and the student to computer ratio of each school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Reading score during the 2014-2015 school year. The ANOVA was not significant, $F(2,559) = 2.12$, $p = .12$, partial $\eta^2 = .007$. Therefore, the null hypothesis was retained. In summary, a high or low computer ratio is not necessarily associated with high or low 6th grade Reading scores. The means and standard deviations for TCAP mean Reading scores are reported in Table 1.

Table 1
Means and Standard Deviations for TCAP Mean Scores in Reading

Students to Computer Ratio	N	M	SD
High Technology	128	48.54	7.38
Middle Technology	303	49.51	6.73
Low Technology	131	48.11	7.39

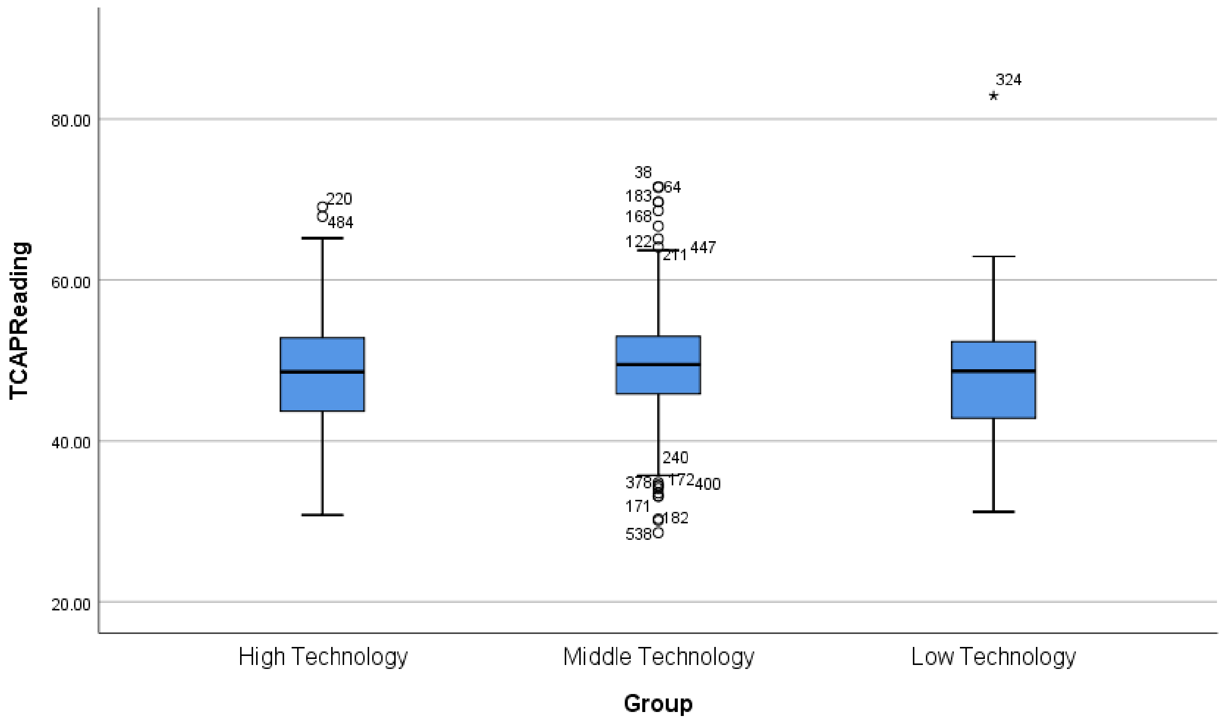

Figure 1: Distribution of TCAP Reading Means by Students to Computer Ratios

o indicate cases with extreme values

H_01_2: There is not a significant difference in 6th graders' TCAP mean scores in Math during the 2014-2015 school year as compared by the ratio of students to computer.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Math scores during the 2014-2015 school year and the students to computer ratio of each school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Math score during the 2014-2015 school year. The ANOVA was not significant, F (2,559) = .08, p = .93, partial $\eta^2 < .001$. Therefore, the null hypothesis was retained. In summary, a high or low computer ratio is not necessarily associated with high or low 6th grade

Math scores. The means and standards deviations for TCAP mean Math scores are reported in Table 2.

Table 2
Means and Standard Deviations for TCAP Mean Scores in Math

Students to Computer Ratio	N	M	SD
High Technology	128	48.63	8.31
Middle Technology	303	48.95	7.58
Low Technology	131	48.81	8.17

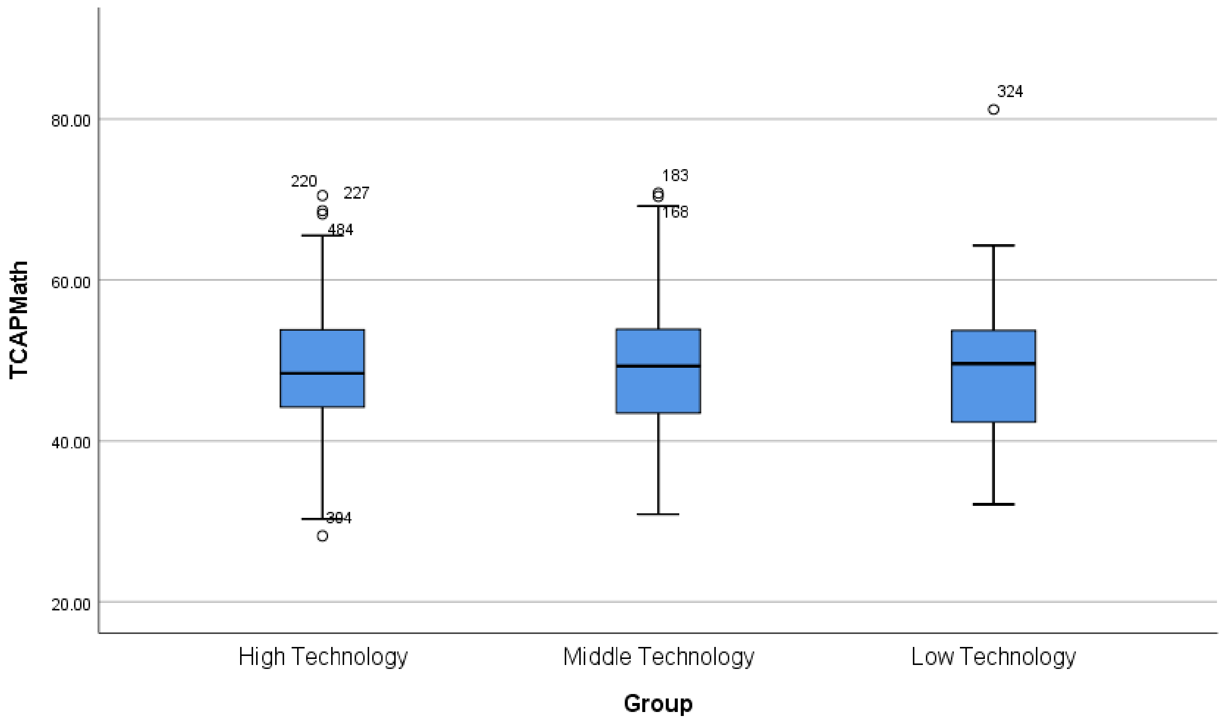

Figure 2: Distributions of TCAP Math Means by Students to Computer Ratios
o indicate cases with extreme values

Research Question 2

Is there a significant relationship between the change in ratio of students to computer and the change in the mean student achievement scores from 2013-2014 to 2014-2015?

$H_0 2_1$: There is not a significant relationship between the change in ratio of students to computer and the change in 6th graders' TCAP mean scores in Reading from 2013-2014 to 2014-2015?

Correlation coefficients were computed between the change in 6th graders' TCAP mean scores in Reading and the change in ratio of students to computer from 2013-2014 to 2014-2015. The results of the analysis revealed a weak relationship between the change in TCAP Reading mean scores (*M* = -.2313, *SD* = 3.95) and the change in the students to computer ratio (*M* =

-10.32, *SD* = 79.20) scores. The -10.32 indicates the lowering of the students to computer ratio. The results of the correlational analysis shows that the correlation was not statistically significant, $r(560) = 0.03$, $p = .49$. Therefore, the null hypothesis was retained. In general, a high or low ratio of computers is not necessarily associated with a change in 6^{th} grade Reading scores.

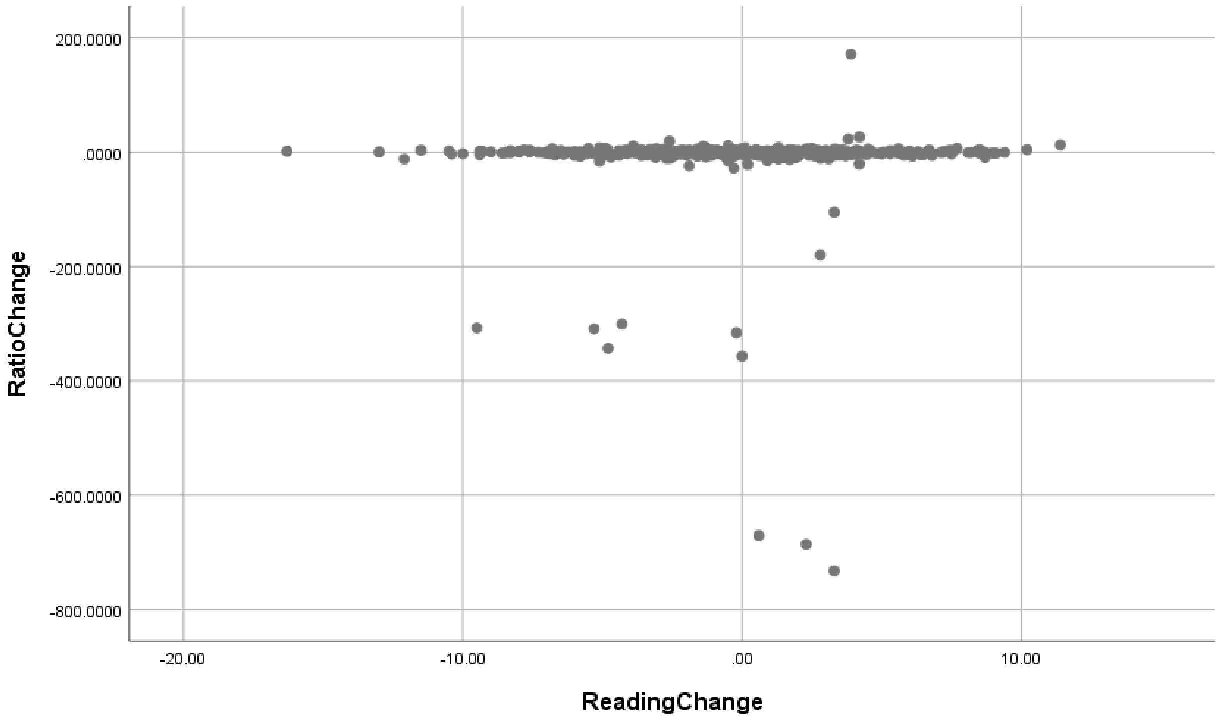

Figure 3: Change in the students to computer ratio and the change in TCAP Reading means from 2013-2014 to 2014-2015.

H_02_2: There is not a significant relationship between the change in ratio of students to computer and the change in 6^{th} graders' TCAP mean scores in Math from 2013-2014 and 2014-2015?

Correlation coefficients were computed between the change in 6th graders' TCAP mean scores in Math and the change in ratio of students to computer from 2013-2014 and 2014-2015. The results of the analysis revealed a weak relationship between the change in TCAP Math mean scores (*M* = -.1162, *SD* = 4.88) and the change in the student to computer ratio (*M* = -10.32, *SD* = 79.20) scores. The -10.32 indicates the lowering of the students to computer ratio. The results of the correlational analysis shows that the correlation was not statistically significant, $r(560) = 0.06$, $p = .17$. The ratio of students to computer in a school does not correlate to 6th grade Math test scores. Therefore, the null hypothesis was retained. A high or low ratio of computers is not necessarily associated with a change in 6th grade Math scores.

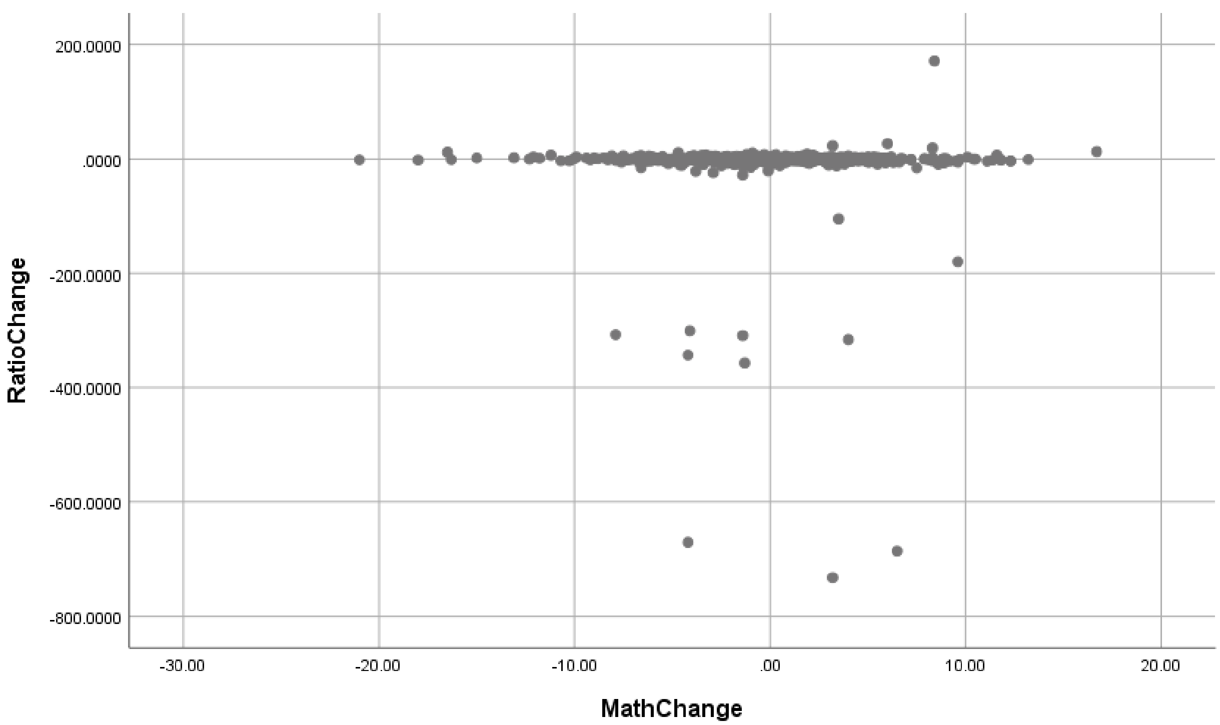

Figure 4: Change in students to computer ratio and the change in TCAP Math means from 2013-2014 to 2014-2015.

Research Question 3

Is there a significant difference between the ratio of students to computer and school socioeconomic status during the 2014-2015 school year?

H_03_1: There is not a significant difference between the ratio of students to computer and school socioeconomic status during the 2014-2015 school year.

An independent-samples t test was conducted to evaluate the hypothesis that there is not a significant difference between the ratio of students to computer and school socioeconomic status. The ratio of students to computer was the test variable and the grouping variable was school SES. The test was not significant, $t(560) = .102$, $p = .92$. Students in non-low SES schools (M = 4.68, SD = 9.05) did not tend to have a greater number or fewer number of computers than those in the low SES schools (M = 4.61, SD = 3.74). Therefore, the null hypothesis was retained. Low SES school tended to have a similar student to computer ratio average as non-low socioeconomic schools. To summarize, a high or low ratio of computers is not necessarily connected to low or non-low school socioeconomic status. The 95% confidence interval for the difference in means was -1.34 to 1.49. Figure 5 shows the distributions for the two groups.

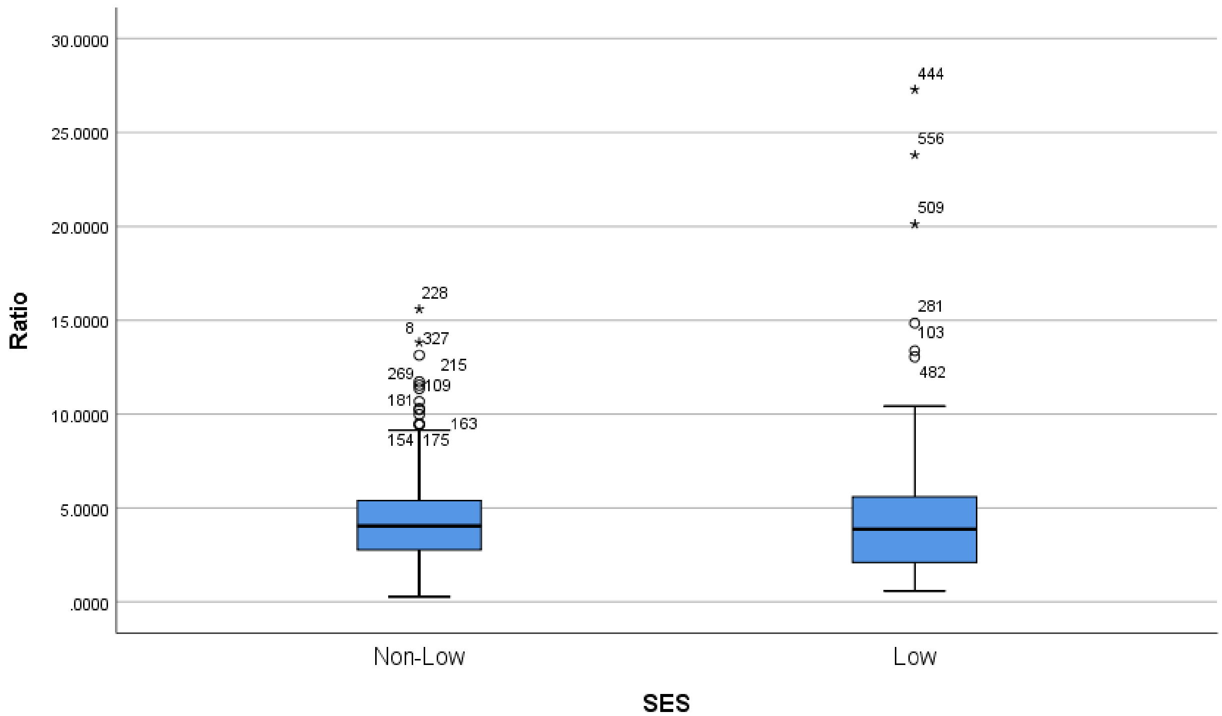

Figure 5: Distribution of Students to Computer Ratios for Low and Non-Low SES Schools

o indicate cases with extreme values

Research Question 4

Is there a significant difference in mean student achievement scores from 2014-2015 as compared by ratio of students to computer and the school socioeconomic status?

H_04_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by ratio of students to computer and school socioeconomic status.

A 3 X 2 ANOVA was conducted to evaluate the effects of three student to computer ratios and two school socioeconomic statuses on 6th grade TCAP mean scores in Reading from 2014-2015. The means and standard deviations for 6th grade TCAP mean scores in Reading as a function of the two factors are presented in Table 5. The ANOVA indicated no significant interaction between student to computer ratio and school SES, $F(2,556) = .001$, $p = .99$, partial η^2

< .001. The ANOVA also indicated no significant main effects for student to computer ratio, $F(2,556) = 1.72$, $p = .18$, partial $\eta^2 = .01$ and no significant main effects for school SES, $F(1,556) = .002$, $p = .97$, partial $\eta^2 < .001$. Therefore, the null hypothesis was retained. In summary, a high or low ratio of computers and a low or non-low school socioeconomic status is not necessarily associated with high or low 6th grade Reading scores.

Table 3
Means and Standard Deviations for TCAP Mean Scores in Reading

Students to Computer Ratio	School SES	M	SD
High Technology	Non-Low	48.56	7.96
	Low	48.51	6.61
Middle Technology	Non-Low	49.51	6.77
	Low	49.51	6.68
Low Technology	Non-Low	48.12	7.56
	Low	48.09	7.12

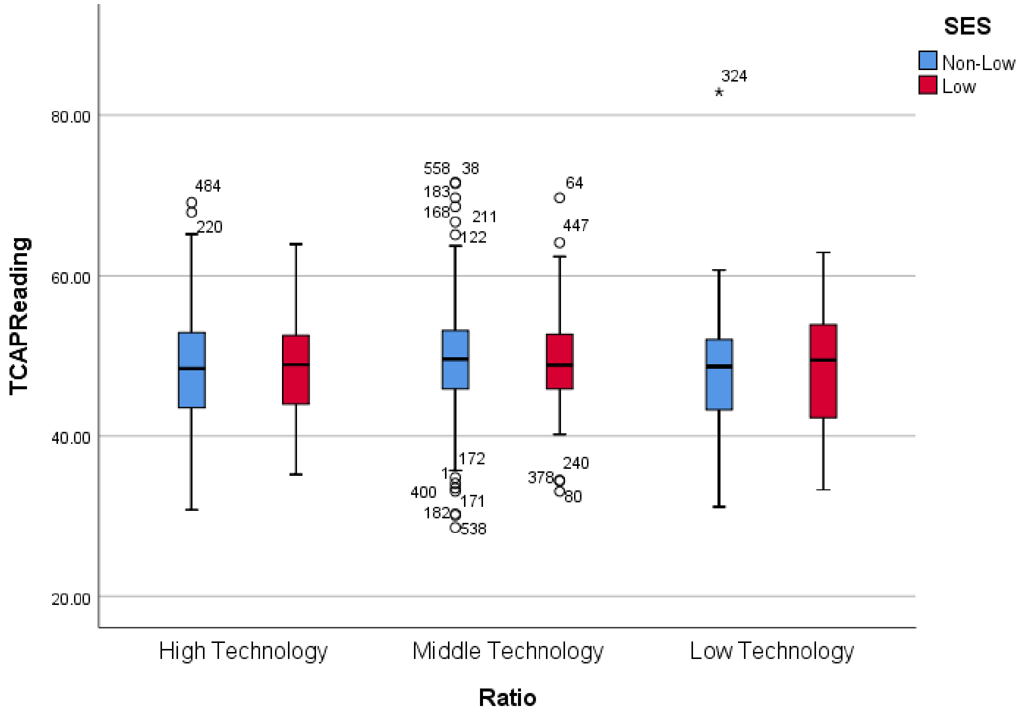

Figure 6: Distributions of TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools

o indicate cases with extreme values

H_04_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by ratio of students to computer and school socioeconomic status.

A 3 X 2 ANOVA was conducted to evaluate the effects of three students to computer ratios and two school socioeconomic statuses on 6th grade TCAP mean scores in Math from 2014-2015. The means and standard deviations for 6th grade TCAP mean scores in Math as a function of the two factors are presented in Table 6. The ANOVA indicated no significant interaction between students to computer ratio and school SES, $F(2,556) = .20$, $p = .82$, partial $\eta^2 = .001$. The ANOVA also indicated no significant main effects for students to computer ratio, $F(2,556) = .08$, $p = .93$, partial $\eta^2 < .001$ and no significant main effects for school SES, $F(1,556)$

= .11 , *p* = .74, partial $\eta^2 < .001$. Therefore, the null hypothesis was retained. In summary, a high or low ratio of computers and a low or non-low school socioeconomic status is not necessarily associated with high or low 6th grade Math scores.

Table 4
Means and Standard Deviations for TCAP Mean Scores in Math

Students to Computer Ratio	School SES	M	SD
High Technology	Non-Low	49.02	8.80
	Low	48.11	7.67
Middle Technology	Non-Low	49.01	7.59
	Low	48.78	7.59
Low Technology	Non-Low	48.69	8.74
	Low	49.06	6.93

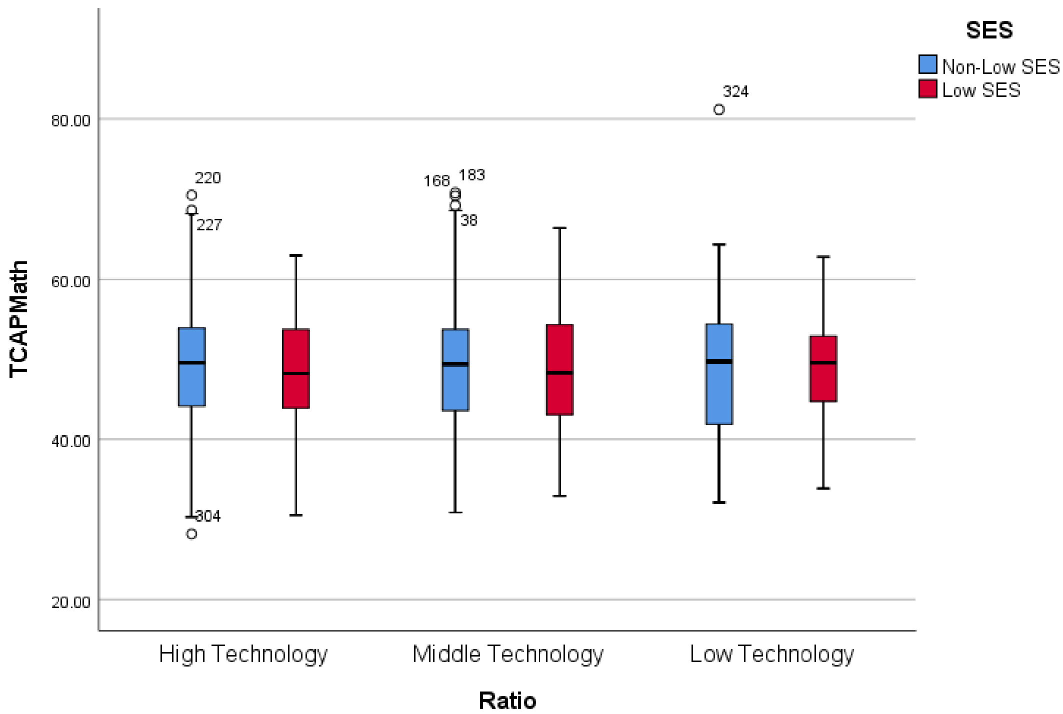

Figure 7: Distributions of TCAP Math Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools

o indicate cases with extreme values

Research Question 5

Is there a significant difference in the change in mean student achievement scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and the school socioeconomic status?

H_05_1: There is not a significant difference between the change in 6th grade Reading mean scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and school socioeconomic status.

A 3 X 2 ANOVA was conducted to evaluate the effects of the students to computer ratios and two school socioeconomic statuses on the change in 6th grade TCAP mean scores in Reading from 2013-2014 to 2014-2015. The ANOVA indicated no significant interaction between the change in students to computer ratio and school SES, $F(2,556) = 1.78$, $p = .17$, partial $\eta^2 = .01$. The ANOVA also indicated no significant main effects for the student to computer ratio, $F(2,556) = .20$, $p = .82$, partial $\eta^2 = .001$ and no significant main effects for school SES, $F(1,556) = .52$, $p = .47$, partial $\eta^2 = .001$. Therefore, the null hypothesis was retained. A high or low ratio of computers and a low or non-low school socioeconomic status is not necessarily associated with the change in 6th grade Reading scores. The means and standards deviations for the change in TCAP mean scores in Reading are reported in Table 7.

Table 5

Means and Standard Deviations for the Change in TCAP Mean Scores in Reading

Students to Computer Ratio	School SES	M	SD
High Technology	Non-Low	.17	3.81
	Low	-1.00	3.85
Middle Technology	Non-Low	-1.00	3.77
	Low	-.50	4.45
Low Technology	Non-Low	-.46	4.18
	Low	.27	3.95

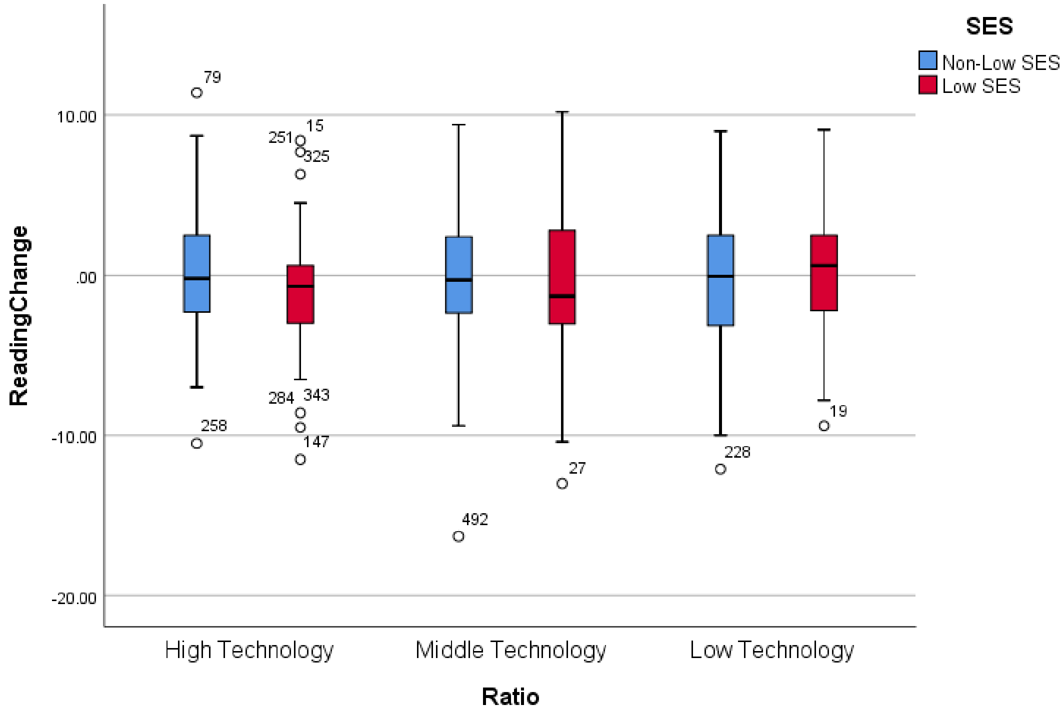

Figure 8: Distributions of the Change in TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools

o indicate cases with extreme values

H_05_2: There is not a significant difference between the change in 6th grade Math mean scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and school socioeconomic status.

A 3 X 2 ANOVA was conducted to evaluate the effects of the change in student to computer ratios and two school socioeconomic statuses on the change in 6th grade TCAP mean scores in Math from 2013-2014 to 2014-2015. The ANOVA indicated no significant interaction between students to computer ratio and school SES, $F(2,556) = .68$, $p = .51$, partial $\eta^2 = .002$. The ANOVA also indicated no significant main effects for students to computer ratio, $F(2,556) = 2.37$, $p = .09$, partial $\eta^2 = .008$ and no significant main effects for school SES, $F(1,556) = .31$, *p*

= .58, partial η^2 = .001. Therefore, the null hypothesis was retained. A high or low ratio of computers and a low or non-low school socioeconomic status is not necessarily associated with the change in 6th grade Math scores. The means and standards deviations for the change in TCAP mean scores in Math are reported in Table 8.

Table 6
Means and Standard Deviations for TCAP Mean Scores in Math

Students to Computer Ratio	School SES	M	SD
High Technology	Non-Low	-.30	5.21
	Low	-1.36	5.72
Middle Technology	Non-Low	-.08	4.60
	Low	-.17	4.54
Low Technology	Non-Low	.36	5.11
	Low	.71	4.65

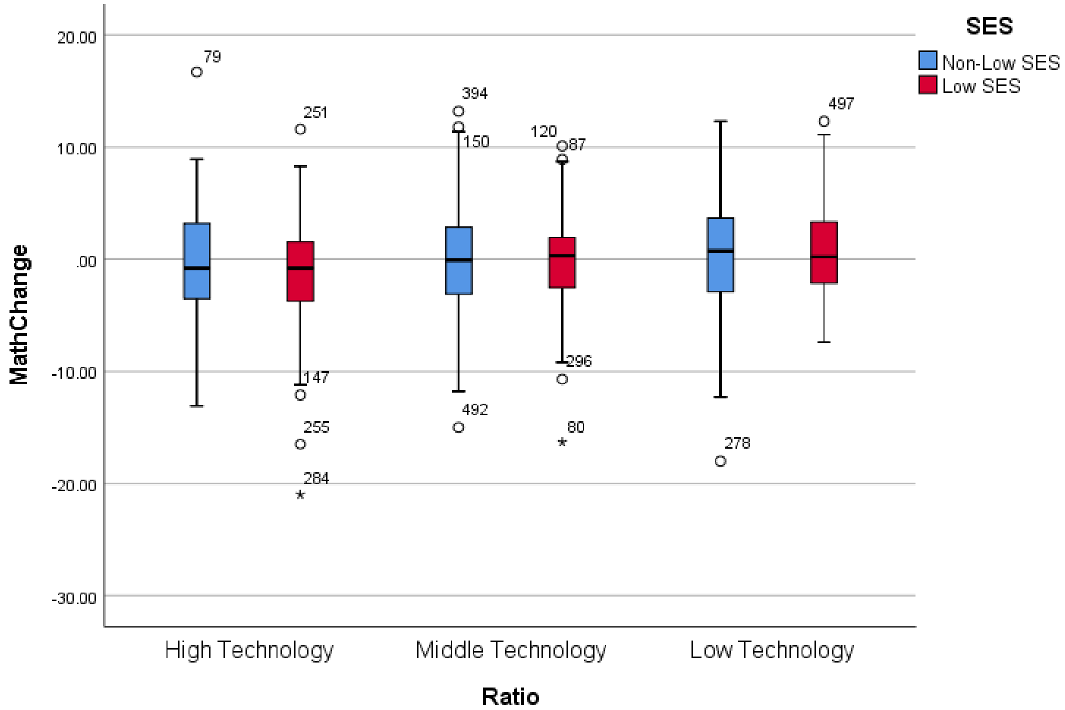

Figure 9: Distributions of the Change in TCAP Math Mean Scores by Students to Computer Ratio for Non-Low SES and Low SES Schools

o indicate cases with extreme values

Research Question 6

Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools?

H_06_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Reading scores during the 2014-2015 school year and the students to computer ratio of each low socioeconomic school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Reading score during the 2014-2015 school year. The ANOVA was not significant, F (2,167) = .68, p = .51, partial η^2 = .01. Therefore, the null hypothesis was retained. For low socioeconomic schools, a high or low ratio of computers is not necessarily associated with high or low 6th grade Reading scores. The means and standards deviations for TCAP mean scores in Reading in low SES schools are reported in Table 9.

Table 7

Means and Standard Deviations for TCAP Mean Scores in Reading in Low SES Schools

Students to Computer Ratio	N	M	SD
High Technology	55	48.51	6.61
Middle Technology	72	49.51	6.68
Low Technology	43	48.09	7.12

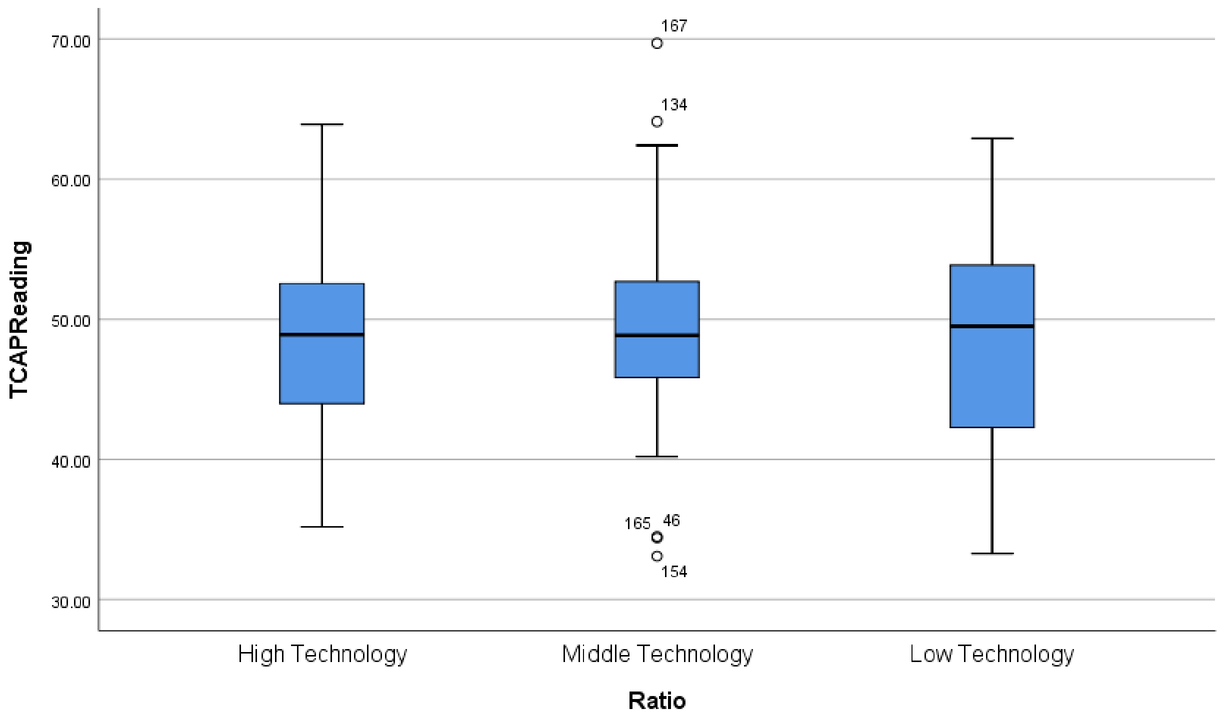

Figure 10: Distributions of TCAP Reading Mean Scores by Students to Computer Ratio for Low SES Schools

o indicate cases with extreme values

H_06_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Math scores during the 2014-2015 school year and the students to computer ratio of each low socioeconomic school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Math score during the 2014-2015 school year. The ANOVA was not significant, F (2,167) = .22, p = .80, partial η^2 = .003. Therefore, the null hypothesis was retained. For low socioeconomic schools, a high or low ratio of computers is not necessarily associated with high or low 6th grade Math scores. The means and standards deviations for TCAP mean scores in Math in low SES schools are reported in Table 10.

Table 8

Means and Standard Deviations for TCAP Mean Scores in Math for Low SES Schools

Students to Computer Ratio	N	M	SD
High Technology	55	48.11	7.67
Middle Technology	72	48.78	7.59
Low Technology	43	49.06	6.93

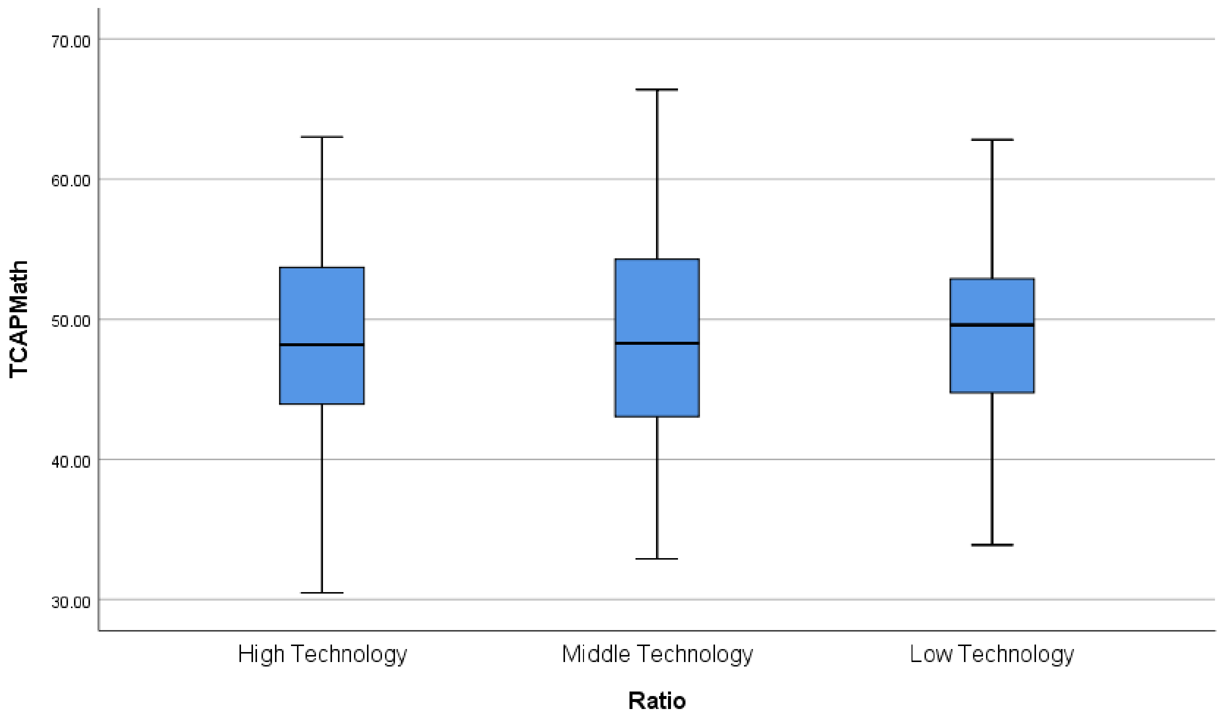

Figure 11: Distributions of TCAP Math Mean Scores by Students to Computer Ratios for Low SES Schools

o indicate cases with extreme values

Research Question 7

Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer and non-low socioeconomic schools?

H_07_1: There is not a significant difference in 6th graders' TCAP mean scores in Reading from 2014-2015 as compared by the ratio of students to computer and non-low school socioeconomic status.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Reading scores during the 2014-2015 school year and the students to computer ratio of each non-low socioeconomic school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Reading score during the 2014-2015 school year. The ANOVA was not significant, F (2,389) = 1.51, p = .22, partial η^2 = .01. Therefore, the null hypothesis was retained. For non-low socioeconomic schools, a high or low ratio of computers is not necessarily associated with high or low 6th grade Reading scores. The means and standards deviations for TCAP mean scores in Reading in non-low SES schools are reported in Table 11.

Table 9
Means and Standard Deviations for TCAP Mean Scores in Reading for Non-Low SES Schools

Students to Computer Ratio	N	M	SD
High Technology	73	48.47	7.94
Middle Technology	231	49.54	6.77
Low Technology	88	48.12	7.56

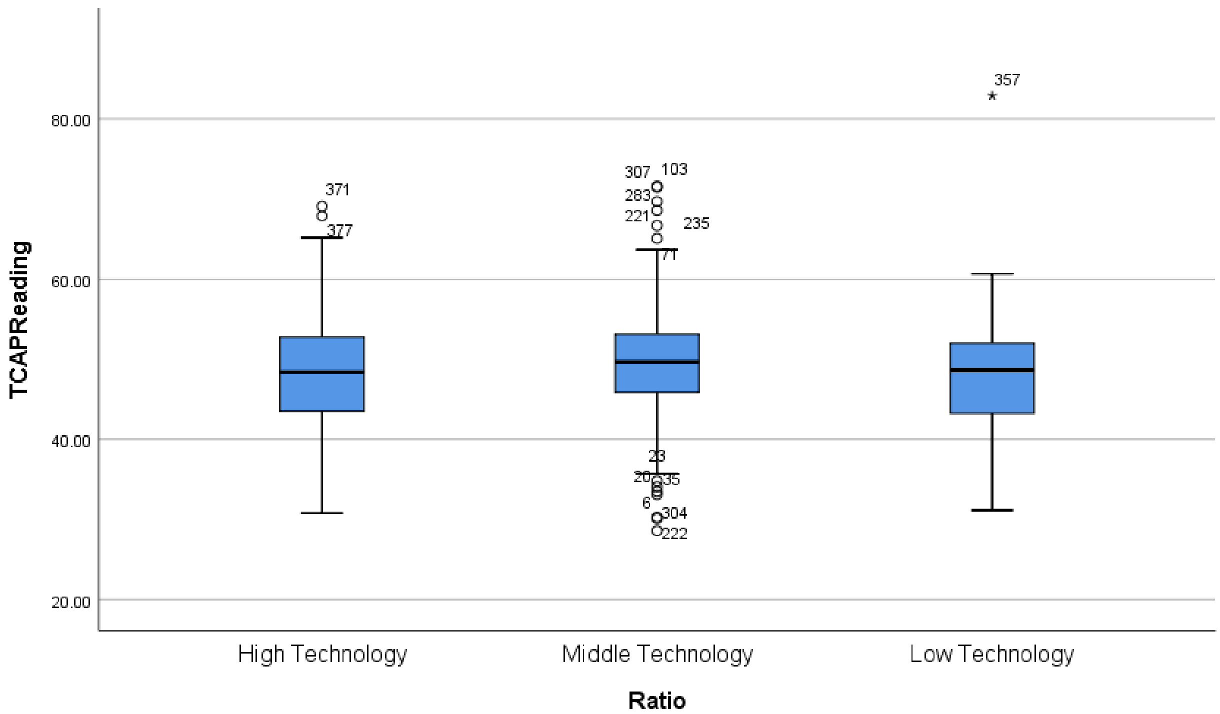

Figure 12: Distributions of TCAP Reading Mean Scores by Students to Computer Ratio for Non-Low SES Schools

o indicate cases with extreme values

H_07_2: There is not a significant difference in 6th graders' TCAP mean scores in Math from 2014-2015 as compared by the ratio of students to computer and non-low school socioeconomic status.

A one-way analysis of variance was conducted to evaluate the relationship between mean 6th grade Math scores during the 2014-2015 school year and the students to computer ratio of each non-low socioeconomic school. The independent variable, the students to computer ratio factor, included three levels: high technology, middle technology, and low technology. The dependent variable was the mean 6th grade Math score during the 2014-2015 school year. The

ANOVA was not significant, F (2,389) = .08, p = .93, partial $\eta^2 < .001$. Therefore, the null hypothesis was retained. For non-low socioeconomic schools, a high or low ratio of computers is not necessarily associated with high or low 6th grade Math scores. The means and standards deviations for TCAP mean scores in Math in non-low SES schools are reported in Table 12.

Table 10
Means and Standard Deviations for TCAP Mean Scores in Math in Non-Low SES Schools

Students to Computer Ratio	N	M	SD
High Technology	73	48.83	8.83
Middle Technology	231	49.07	7.57
Low Technology	88	48.69	7.39

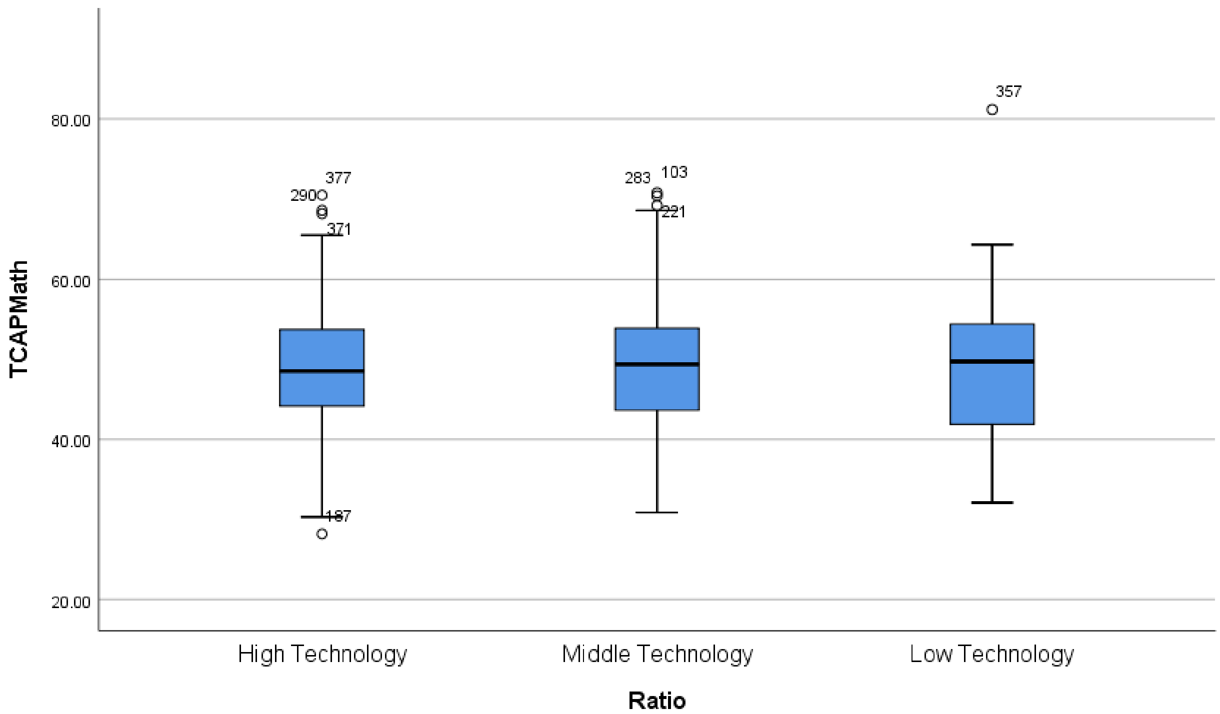

Figure 13: Distributions of TCAP Math Mean Scores by Students to Computer Ratios for Non-Low SES Schools

o indicate cases with extreme values

Chapter Summary

Analysis of the data collected from the 2013 through 2015 school years directed the researcher to observe that among the three groups high technology, middle technology, and low technology, neither the low SES nor non-low SES schools had significant differences in TCAP Reading or Math scores. In addition, when comparing low SES to low SES and non-low SES to non-low SES there was no significant differences in TCAP Reading or Math scores.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine if there was a significant relationship between the students to computer ratio and 6^{th} grade student achievement in Math and Reading during the 2013-2014 and 2014-2015 school years as compared by school socioeconomic status. The TCAP scores in Math and Reading, the students to computer ratio of each school, and the percentage of eligible free-reduced lunch students were collected via electronic data accessed from the TNDOE and TVAAS public data websites. The data analyses reported were based on thirteen hypotheses that were tested at a .05 level of significance. The independent variables in the study were the ratio of students to computer (low/middle/high), the change in students to computer ratio, and SES (low/non-low). The dependent variables in the study were 6^{th} grade mean Reading scores for 2014-2015, 6^{th} grade mean Reading gain scores from 2013-2014 to 2014-2015, 6^{th} grade mean Math scores for 2014-2015, and 6^{th} grade mean Math gain scores from 2013-2014 to 2014-2015. The sample for this study was 562 schools that had reported achievement scores, school computer numbers, and percentage of economically disadvantaged students.

Conclusions

Research Question 1: Is there a significant difference in mean student achievement during the 2014-2015 school year as compared by the ratio of students to computer?

TCAP Reading. There is not a significant difference in the Reading means between students in high, middle, or low technology schools. Students in schools with more computers did not perform significantly better on the Reading TCAP test than students in schools with fewer computers.

TCAP Math. There is not a significant difference in the Math means between students in high, middle, or low technology schools. Students in schools with more computers did not perform significantly better on the Math TCAP test than students in schools with fewer computers.

These findings are consistent with Chung's findings (2002). When examining the impact of the students to computer ratio on student achievement, there was not a significant difference in high, middle, or low technology schools.

Research Question 2: Is there a significant relationship between the change in ratio of students to computer and the change in the mean student achievement scores from 2013-2014 to 2014-2015?

TCAP Reading. The correlation was not statistically significant. An increase in the number of computers in a school did not necessarily correlate with an increase or decrease in Reading achievement scores.

TCAP Math. The correlation was not statistically significant. An increase in the number of computers in a school did not necessarily correlate with an increase or decrease in Math achievement scores.

Though it might be assumed that as computers increase, student achievement increases, there was little correlation between the change in students to computer ratio and the change in student achievement. These findings are related to that of Leuven, Lindahl, Oosterbeek, and

Webbink (2004). In their study, low income schools received increased funding towards additional computers. As a result, student achievement scores did not increase.

Research Question 3: Is there a significant difference between the ratio of students to computer and school socioeconomic status during the 2014-2015 school year?

The results of the test were not significant. Schools with a high number of low socioeconomic or non-low socioeconomic students are not necessarily associated with a high, middle, or low students to computer ratio.

These findings are consistent with Warschauer, Knobel, and Stone (2004). When they researched technology at high and low SES schools, they indicated that the schools in the study had similar students to computer ratios no matter their socioeconomic status. They also indicate that this is consistent with other research across the U.S. regarding the diminishing gap in resources between high SES and low SES schools.

Research Question 4: Is there a significant difference in mean student achievement scores from 2014-2015 as compared by ratio of students to computer and the school socioeconomic status?

TCAP Reading: There was no significant interaction between the students to computer ratio and school socioeconomic status on Reading achievement. The interaction between the high, middle, or low computer ratio and low or non-low school SES did not necessarily relate to high or low 6th grade Reading scores.

TCAP Math: There was no significant interaction between the students to computer ratio and school socioeconomic status on Math achievement. The interaction between the high, middle, or low computer ratio and low or non-low school SES did not necessarily relate to high or low 6th grade Math scores.

These findings are consistent with Chung's findings (2002). When examining the interaction between the students to computer ratio and socioeconomic status on student achievement, there was not a significant difference in high, middle, or low technology schools.

Research Question 5: Is there a significant difference in the change in mean student achievement scores from 2013-2014 to 2014-2015 as compared by the change in ratio of students to computer and the school socioeconomic status?

TCAP Reading: There was no significant interaction between the students to computer ratio and school socioeconomic status on the change in Reading achievement. The interaction between the high, middle, or low computer ratio and low or non-low school SES did not necessarily relate to the increase or decrease in 6th grade Reading scores.

TCAP Math: There was no significant interaction between the students to computer ratio and school socioeconomic status on the change in Math achievement. The interaction between the high, middle, or low computer ratio and low or non-low school SES did not necessarily relate to the increase or decrease in 6th grade Math scores.

These findings are consistent with Chung's findings (2002). When examining the interaction between the students to computer ratio and socioeconomic status on the change in student achievement, there was not a significant difference in high, middle, or low technology schools.

Research Question 6: Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer for low socioeconomic schools?

TCAP Reading. There is not a significant difference in the Reading means for low SES schools among students in high, middle, or low technology schools. Students in low SES schools with more computers did not perform significantly better on the Reading TCAP test than students in low SES schools with fewer computers.

TCAP Math. There is not a significant difference in the Math means for low SES schools among students in high, middle, or low technology schools. Students in low SES schools with more computers did not perform significantly better on the Math TCAP test than students in low SES schools with fewer computers.

These findings are not consistent with Chung's findings (2002). When Chung compared low SES schools with other low SES schools, there was a significant difference in Reading and Math. Low socioeconomic schools with high or middle technology performed better than low socioeconomic schools with low technology. It is possible that there was no significant difference in this study because teachers were not using the technology. Although technology increased in these schools in Tennessee, the researcher was unable to determine how often teachers used computers with students.

Research Question 7: Is there a significant difference in mean student achievement scores from 2014-2015 as compared by the ratio of students to computer and non-low socioeconomic schools?

TCAP Reading. There is not a significant difference in the Reading means for non-low SES schools among students in high, middle, or low technology schools. Students in non-low

SES schools with more computers did not perform significantly better on the Reading TCAP test than students in non-low SES schools with fewer computers.

TCAP Math. There is not a significant difference in the Reading means for non-low SES schools among students in high, middle, or low technology schools. Students in non-low SES schools with more computers did not perform significantly better on the Reading TCAP test than students in non-low SES schools with fewer computers.

These findings are somewhat consistent with Chung's findings (2002). When Chung compared middle SES schools with other middle SES schools, there was a significant difference in Math. Middle socioeconomic schools with higher technology performed better than middle socioeconomic schools with low technology. Although SES groups were organized differently in this study, outcomes can still be compared. Again, it is possible that there was no significant difference in this study the researcher was unable to determine how much time teachers used computers with students.

Recommendations for Practice

Computers in schools are here to stay. Teachers must utilize technology in a way that is unique and beneficial to student learning. True technology integration is about teaching students to think critically and create their own meaning out of the learning experiences offered to them (Smith, 2013). In order for schools to truly shape today's world, it is essential that teachers and school leaders have a clear strategy toward implementing technology (Hew & Brush, 2006). Students want instructional opportunities with technology that fit with their world. Although the findings in this study on the relationship between the students to computer ratio and student achievement as compared by school socioeconomic status were not statistically significant, computers will remain in schools and continue to be used by students. Therefore, the following recommendations have been made for future practice:

1. School leaders should reallocate resources and collaboratively plan for technology integration in order to assure successful technology implementation.
2. Teachers should utilize computers in developing individualized learning opportunities containing higher order skills which maximize the impact of technology and learning.
3. School leaders should offer professional development opportunities to better support teachers in developing content related technology activities, so that these activities do more than just replace the same activities done on pencil and paper.
4. State leaders should add a specific technology component to the teacher evaluation model that addresses using content-related strategies on student devices.

Recommendations for Future Research

The findings of this study revealed no significant relationship between the students to computer ratio in low and non-low socioeconomic schools and 6^{th} grade student achievement. The following recommendations are suggested for those interested in the relationship between students to computer ratios and achievement as compared by socioeconomic status:

1. The researcher used Chung's (2001) study as a framework for this study. However, modifications were made to make this study more applicable to the current technology situation. Therefore, one recommendation for further research is to conduct an exact replication of Chung's original study to see if similar results are found years later at the same grade level.

2. Researchers have encouraged teachers to heed warning about how they are using computers in classrooms (Celano & Neuman, 2010; Hohlfeld et al., 2008; Li & Ranieri, 2013; Mouza 2008; Warschauer, Knobel, & Stone, 2004), which is why it is crucial to continue to evaluate how teachers are using technology in their classrooms on a regular basis. Therefore, a study should be conducted on the relationship between how teachers use technology in their classrooms and achievement scores.
3. The researcher examined 6th grade achievement scores for two consecutive years following two different cohorts of students. Therefore, a study should be conducted to follow one cohort of students from 6th to 7th grade as students to computer ratios change. Following a specific group would allow the researcher to collect data on the same group of students while eliminating other factors that could affect changes in achievement.
4. This study should be replicated using other grade levels to determine whether the results are similar between grade levels.

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