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A Study of One-to-One Computer Usage and Student Levels of Engagement and Rigor and Teacher Perception

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Levels of Engagement and Rigor and Teacher Perception

by

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Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Abstract

At the time of this writing, one-to-one technology programs at the secondary level were increasingly common in public schools in the United States. The debate over the value and benefit technological devices provided continues. The researcher compared observational data from a school prior to one-to-one computer implementation and post one-to-one computer implementation, collecting the Depth of Knowledge associated with the classroom learning activity. Using a rigor and engagement technology tool for data collection, classrooms were observed the year prior to a one-to-one program and then the following year, during the implementation.

This quantitative study revealed the overall rigor levels did not significantly change when comparing total observations for the pre-to-post implementation years. The researcher found a significant difference when comparing the Depth of Knowledge level in classrooms using technology devices from the pre-to-post implementation years. Students' engagement with technology increased 62% on average from pre- to post-year data. The researcher evaluated the Substitution, Augmentation, Modification, and Redefinition (SAMR) levels of the learning activities to determine if the technology use included simple substitution, augmentation, modification, or redefinition (Puentedura, 2009). The significant difference in learning activity types, combined with the difference in rigor levels for the pre- and post-year corresponded to a difference in SAMR transformational steps.

Findings in this study also revealed teachers generally perceived universally available access to technology devices and internet to students was beneficial to the learning environment.

Table of Contents

List of Tables

List of Figures

Chapter One: Introduction

Introduction

For more than 20 years, schools utilized technology within the classroom and technology became ever-present in school buildings. “Media and technology companies — including News Corp, Apple, and Microsoft — have significantly expanded their presence in public schools to sell hardware and curriculum products such as tablets and learning software aligned with the Common Core State Standards” (Saltman, 2016, p. 105).

As a major component influencing modern education, the emergence of technological devices, programs, and resources in classrooms contributed to transformative ideas moving into the future. Internet access in schools and communities became a necessary component of district resource allocation (U.S. Department of Education, 2016). Increasingly affordable, computers and electronic devices became commonplace in classrooms and for individual students throughout the country (Zheng, Warschauer, Lin, & Chang, 2016, p. 1053). Teachers and administrators faced the task of incorporating levels of technology usage, often without sufficient guidance on student impact and delivery of learning experiences.

Puentedura (2009) coined the Substitution, Augmentation, Modification, and Redefinition (SAMR) method of evaluating technology in the classroom. The evaluation analyzed the degree to which technology was influencing student activities and assignments (Puentedura, 2009). In this study, the SAMR levels were used in observations to determine the breadth of how technology was used in lessons by teachers.

Purpose of the Study

The purpose for the study was to analyze the educational rigor in the classroom as the amounts of technology usage increased, to consider the educational value of technology usage. The researcher compared pre/post observational data prior to one-to-one computer implementation, specifically focusing on the Depth of Knowledge (DOK) associated with the learning activity. The researcher evaluated the SAMR level of the learning activities to determine if the technology use was simple substitution, augmentation, modification, or redefinition (Puentedura, 2009). In addition, the researcher looked at indicators of rigor by utilizing Norman Webb's Depth of Knowledge levels (Webb, 2002). The researcher determined whether a statistical difference existed between the prior to one-to-one computer implementation and post one-to-one computer implementation observed data points.

Rationale of Study

There has been a substantial increase in educational technology in the 21st century (Office of Educational Technology, 2016). How the technology, along with the accompanying specific teaching and learning practices, influenced the student learning experience and academic outcomes requires itemized additional research that isolated key the factors.

"With the growth in using digital media and technology by K-12 students, and wider availability of technology in households, school districts are experiencing pressure from stakeholders to incorporate technology" (Topper & Lancaster, 2013, p. 347). Students had more access to computers and technology during instructional hours than in previous decades and across the country are investing in individual devices, such as personal laptop computers and tablets.

Specifically, one-to-one computer programs have become a common aspect of modern education. "The impact of 1:1 learning on student measures and outcomes has been examined and studied from several different angles, from looking at absentee rates to interest and motivation to achievement scores" (Holcomb, 2009, p. 49). This study focused on analyzing the differences in rigor and engagement from pre-to-post one-to-one computer implementation. In addition, the researcher surveyed teachers to analyze educator perception concerning how the one-to-one implementation may have created differences in student measures on rigor and engagement.

Technology has consumed almost every aspect of our lives. Educators "must understand the possibilities of the new technologies from the inside if we want to guide the future of education" (Collins & Halverson, 2009, p. 122). While projections may state that technology will transform education, providing technology for students may also improve academic performance and achievement (Jackson, Helms, Jackson, & Gum, 2011). Additional research adding to current literature may increase understanding of the depth of student growth and the contributing factors surrounding technology and devices in education. Teachers may have an interpretation as to how technology affects students. The researcher investigated how educational technology, in particular, a one-to-one program, may create difference in elements of student rigor and engagement in the classroom. Data derived from pre-and-post one-to-one computer implementation observations helped to create a sense of the change in student learning outcomes that technology has on classrooms.

Hypotheses

The researcher investigated in order to determine if there were significant differences among the following variables.

H1: There is a difference in the Depth of Knowledge observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H2: There is a difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H3: There is a difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H4: There is a difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H5: There is a difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H6: The average Likert-type scale rating for teacher responses to survey statements are different from the neutral (3.0).

Study Limitations

The researcher identified limitations in this study. The results of this study were limited to the survey responses of teacher participants included in the one-to-one implementation. In terms of grade level and age of the observed population, classrooms observed were limited to sixth, seventh, and eighth grade with students ranging in ages from 11 to 15. The researcher used participants from a single school located in a semi-rural community to gather data. This was the only middle school in the district of study.

Classrooms were entered without prior notice to the teacher that an observation was to occur. The data were from brief classroom observations and did not take into account information in lesson plans. A disproportionate amount of observations were in the mornings, per data collectors' schedule. Equality in timeframes and content of classroom observation were not equally distributed. For example, more math classes were observed than choir classes due to more opportunities available during the timeframe of observations.

In terms of the teacher perception of student rigor and engagement while utilizing one-to-one technology, the researcher did not assign baseline surveys for the participants to state pre-perception data on Depth of Knowledge, SAMR, and other factors prior to the implementation of a one-to-one computer usage program.

Definition of Terms

Augmentation- A stage in the SAMR model in which technology is used as substitute, with operative improvement (Puentedura, 2009).

Blended Learning-

> A formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace; at least in part in a supervised brick-and-mortar location away from home; and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience. (Clayton Christensen Institute, 2019, p. 1)

Depth of Knowledge - Webb's (2002) Depth of Knowledge (DOK) levels were used by the researcher in reference to the rigor levels observed in classrooms. Level One: Recall, level two: Skill/concept, level three: Strategic thinking, and level four: Extended thinking (Webb, 2002).

Modification- A stage in the SAMR model in which technology supports substantial task remodeling (Puentedura, 2009).

One-to-One - For the purpose of the study, the researcher defined this phrase to mean one computer device for each student. The researcher used various versions of the term one-to-one including numerical representations as 1:1, 1 to 1, or one-to-one.

Redefinition - A stage in the SAMR model in which technology enables creation of new modalities, previously implausible (Puentedura, 2009)

RETT- For the purpose of the study, the researcher used this acronym to refer to the Rigor Engagement Technology Tool utilized for classroom observations.

Rigor - For the purpose of the study, the level of critical thinking required in learning. It was measured using the Depth of Knowledge levels.

SAMR Model - The four stages of technology integration (substitution, augmentation, modification, and redefinition) developed by Puentedura (2009).

Secondary Education - For the purpose of the study, the researcher included grades sixth through 12th.

Substitution - A stage in the SAMR model in which technology as a direct tool substitute, with no operative change (Puentedura, 2009).

Summary

“Computers have increasingly been affecting education, and it seems that they will likely shape the future of education” (Aslan & Reigeluth, 2011, p. 1). This study focused on the differences in learning observed before and after computers became available for ubiquitous use in the classroom. Bill Gates projected “that in the next decade educational technology spending would be about a $9 billion market” (Saltman, 2016, p. 110). Publicly-funded school districts were charged with educating students. The evaluation of how technology influenced activity, rigor, and engagement in lessons allowed educators to provide rationales for the decisions they make when mapping out units and accounting for data generation. In Chapter Two, the researcher reviews literature, studies, and perspectives surrounding technology and learning.

Chapter Two: Review of Literature

Introduction

Modern education has changed over the years. "The design of 20th century teaching emphasized time-based memorization and retelling of facts. Students were passive learners of content knowledge, and demonstrated understanding through routine summative assessment" (Swallow, 2017, p. 158). Preparing students for the challenges of the 21st century required a shift from instilling recall knowledge to understanding how to access information and "the ability to communicate, and opportunities to collaborate on a universal scale" (Swallow, 2017, p. 155). Miller (2015) stated that the teacher's "role in education has shifted from teacher to virtual-learning travel guide" (Miller, 2015, p. 37). With the emergence of ubiquitous access to information through technology, teachers no longer are needed to be the gatekeepers of knowledge to the "sage on the stage" (Miller, 2015, p. 33). Beetham (2013) explored the nuances of the shifting physical and intellectual educational system:

> Papyrus and paper, chalk and print, overhead projectors, educational toys and television, even the basic technologies of writing were innovations once. The networked digital computer and its more recent mobile and wireless counterparts are just the latest outcomes of human ingenuity that we have at our disposal. It is true that none of these technologies has changed human beings' fundamental capacities to learn, if learning is understood in a purely cognitivist terms. But they have profoundly changed how ideas and practices are communicated, and what it means to be a knowledgeable or capable person. (Beetham & Sharpe, 2013, pp. 3-4)

Learners in society were changing and becoming more digital in their communications and competencies (Beetham & Sharpe, 2013, p. 6). Students lived in a digital world, but educators often continued to expect “them to learn through analog means” (Miller, 2015, p. 189).

With widespread access to the internet, social media has allowed people around the work to share and collaborate their work and experiences with the masses (Marcinek, 2015, p. 83). According to Holcomb (2009), “1:1 computing goes beyond the technology. How and why laptops are used in education are critical factors for success” (Holcomb, 2009, p. 54). Whitehead, Jensen, and Boschee (2013) considered the prominence of technology in connection to curriculum as an established truth in society (p. 1). According to Livingston (2009) “Students who use laptops are more motivated and empowered, are more organized and engaged learners, attend school more regularly, advance their knowledge and understanding of technology, and become constructors and designers of information and ideas” (Livingston, 2009, p. 75).

Evidence suggested that students around the country were using one-to-one computer programs and making gains in their academic outcomes (Holcomb, 2009, p. 49). This chapter explored the history and development of one-to-one computer programs and the how they influence various aspects of the students’ educational experience. “Laptops enable students to take their digital assistants everywhere and use them for all kinds of learning activities: writing, sorting, organizing, experimenting, linking, making mistakes that no one sees” (Livingston, 2009, p. 66). However, according to Christensen, Horn, & Johnson (2011) “classrooms look largely the same as they did before the personal computer revolution, and the teaching and learning processes are similar to what they were in the days before the personal computer" (Christensen, Horn, & Johnson, 2011, p. 72). The exploration of best practices, including successful technology incorporation within rigorous instructional activities and high student engagement are components connected to this study.

United States Department of Education Plan for Education Technology

In recent years, computers have made their way into the public-school systems at every level. "Up to the mid-1970s, the educational use of computers was more common in universities, corporate settings, and the military than in K-12 education" (Aslan & Reigeluth, 2011, p. 5). Since the 1980s, "a loosely tied national coalition of public officials, corporate executives, vendors, policymakers, and parents have included in their reform agendas the common goal of creating more access to new technologies in schools" (Cuban, 2001, p. 12). Beginning in 1996, the Secretary of Education, through the Department of Education, has regularly published a National Educational Technology Plan (Office of Educational Technology, 1996). The Office of Educational Technology has provided stakeholders with guidance concerning use of technology in the classroom (Office of Educational Technology, 2017, p. 4).

The NETP established the vision for "learning enabled by technology through building on the work of leading education researchers; district, school, and higher education leaders; classroom teachers; developers; community members and organizations" (United States Department of Education, 2016, p. 1).

The reports outlined what stakeholders could do in order to ensure technology was utilized to provide "authentic learning experiences" for students (United States Department of Education, 2016, p. 1). The NETP provided a vision of what learning through technology looks like and gives recommendations (United States Department of Education, 2017, p. 4).

In 1996, the report highlighted technologic literacy and statistics surrounding technology usage and availability in schools throughout the United States (United States Department of Education, 1996, p. 11). In the 1996 plan, entitled *Getting America's Students Ready for the 21st Century*, it was noted that "only 4 percent of schools have a computer for every five students—a ratio sufficient to allow regular use. Only 9 percent of classrooms have connections to the Internet" (United States Department of Education, 1996, p. 11). The NETP outlined four concrete goals (teacher training, access to computers in classrooms, network/internet connection, and e-learning resources) and followed up with pathways for achieving those goals at a federal and local level (United States Department of Education, 1996, p. 7).

Successful technology-rich schools "spend about three times as much on technology-related costs as do average schools" (United States Department of Education, 1996, p. 27). President William Clinton was a strong proponent of technology in education (Clinton, 1995). "If we make an opportunity for every student, a fact in the world of modems and megabytes, we can go a long way toward making the American Dream a reality for every student. Not virtual reality -- reality for every student" (Clinton, 1995). The report continued to expound upon the powerful possibilities of technology that were becoming available for use in the classroom (United States Department of Education, 1996, p. 17). "New personal computers support 'multimedia' educational software that employs both sound and video to teach students facts and concepts" (United States Department of Education, 1996, p. 17).

In 2000, the second (and final under the Clinton Administration) NETP was published. Updated statistics as of 1999 depicted how “access has increased by 60 percent: 95 percent of schools and 63 percent of classrooms had access to the Internet, providing on average one instructional computer with an internet connect for every nine students” (United States Department of Education, 2000, p. 17). The 1996 Telecommunications Act created the Education Rate (E-rate) program as a provision that “specifies that, upon request, individual telecommunications carriers must provide service to schools and libraries at *‘affordable’* rates” (Federal Communications Commission, 2019). Senator Olympia Snowe, who cosponsored the provision, stated, “this E-rate is absolutely essential in order to help communities and schools all over this country to wire up their classrooms and schools. It is for the future of this country” (United States Department of Education, 2000, p. 17). As of 1999, “over one million classrooms have been wired through the e-rate program. Most of the funding has gone to public schools, with the majority going to high poverty district” (United States Department of Education, 2000, p. 19). While the federal government stepped up to alleviate the costs associated with wiring schools to the internet, there was not a clearly defined program to accompany in order to ensure for effective instructional use (Kent & McNergney, 1999, p. 23).

The 2004 NETP, titled *Toward a New Golden Age in American Education*, conveyed the Office of Educational Technology’s position under the George W. Bush Administration (United States Department of Education, 2004). In updating technology statistics, the NETP stated, “over the past 10 years, 99 percent of our schools have been connected to the internet with a 5:1 student to computer ratio" (United States Department of Education, 2004, p. 10). The 2004 NETP continued with:

> Yet, we have not realized the promise of technology in education. Essentially, providing the hardware without adequate training in its use – and in its endless possibilities, for enriching the learning experience – meant that the great promise of Internet technology was frequently unrealized. Computers, instead of transforming education, were often shunted to a 'computer room' where they were little used and poorly maintained. Students mastered the wonders of the Internet at home, not in school" (United States Department of Education, 2004).

The plan concluded that children were learning about technology prior to public school attendance and that the "largest group of new users of the Internet from 2000-2002 were 2-5 year olds" (United States Department of Education, 2004, p. 17). This plan outlined seven major action steps and recommendations for states, districts, and schools to include in their technology plans (United States Department of Education, 2004, pp. 39-44). The recommendations were to strengthen leadership, consider innovation budgeting, improve teacher training, support e-learning, encourage broadband access, move toward digital content, and integrate their data systems (United States Department of Education, 2004, pp. 39-44). The NETP (2004) represented a shift away from federal educational/government leaders taking the reins on educational technology and placed it in the hands of states, districts, and schools (United States Department of Education, 2004). In addition, this plan acknowledged, "industry is far ahead of education" in the realm of technology (United States Department of Education, 2004, p. 45).

The next NETP, *Transforming American Education: Learning Powered by Technology*, was published in 2010 under the Barrack Obama Administration (United States Department of Education, 2010). This plan addressed five components of education connected to technology: Learning, Assessment, Teaching, Infrastructure, and Productivity (United States Department of Education, 2010).

Learning powered by technology operated on the educational theory that learning is connected to effective teaching and engaging student learning experiences (United States Department of Education, 2010, p. 5). “Technology-based learning resources can give learners choices that keep them engaged in their learning” by “providing personally relevant content, a customized interface, options for difficulty level or alternative learning pathways” (United States Department of Education, 2010, p. 17). Assessment with technology has the capability of providing instant feedback to students and can adapt with the student ability level (United States Department of Education, 2010, p. 33). As an element of teaching practice, technology allows for “connecting with students to personalize and motivate learning” (United States Department of Education, 2010, p. 41). In March of 2010, the Federal Communications Commission released the National Broadband Plan, which included “changes to the E-Rate that would increase the learners’ access to broadband-enabled learning experiences” (United States Department of Education, 2010, p. 53). The productivity component of the 2010 NETP can be summed up as a call to “design, implement, and evaluate technology-powered programs and interventions to ensure students progress seamlessly” through the educational system (United States Department of Education, 2010, p. 74).

The "goal of the many educational technology programs is to reduce educational and social inequity by providing access to digital resources that is lacking in low-income homes" (Zheng et al., 2016, p. 1074). The 2016 NETP, *Future Ready Leaning: Reimagining the Role of Technology in Education*, began with an update from the 2010 NETP. "The conversation has shifted from whether technology should be used in learning to how it can improve learning to ensure that all students have access to high-quality educational experiences" (United States Department of Education, 2016, p. 5). Blended Learning, as defined in the 2016 NETP, is learning "occurring online and in person," (United States Department of Education, 2016, p. 8). Mixing traditional education settings with technological settings enabled students to optimize and personalize their education (United States Department of Education, 2016, p. 10).

The future of learning technology in the 2016 NETP includes "increased use of games and simulations, . . . interactive three-dimensional imaging software, . . . [and] augmented reality" (United States Department of Education, 2016, p. 16). Statistics concerning the equity of access to technology and the internet continued to be a focus of future infrastructure. "Approximately 55 percent of low-income children under the age of 10 in the United Stated lack Internet access at home" (United States Department of Education, 2016, p. 69). Concern for the impact of the "homework gap" between those with internet connection and those without as well as the 2014 increase in E-rate legislation both played into the overarching call for equity throughout socioeconomic and regional differences that exist in the United States (United States Department of Education, 2016, p. 69).

One-to-One Computer Programs

One-to-One computer programs utilize a “ratio that indicates one computer, laptop or tablet for each student” (Neebe & Roberts, 2015, p. 2). One-to-One programs did not, however, specify or prescribe teaching and learning strategies (Bebell & Pedulla, 2015, p. 5). The notion existed that the programs offered students “opportunities for more constructivist pedagogies and student-centered classroom environments, but truly the only unifying feature of any 1:1 program is the ubiquity of the student device, not a specific application or use” (Bebell & Pedulla, 2015, p. 5).

Funding for the initiation of a one-to-one program was often a topic of conversation for school districts looking to elevate student access to educational technology. “1:1 digital initiatives have the ability to transform an educational system. Without a well-planned financial strategy, however, most 1:1 initiatives will fail” (Edwards, 2014, p. 1). External costs outside of the physical devices, such as wireless networks and infrastructure, software, staffing, and repairs, should be into account during the planning process (Edwards, 2014, p. 1). Funding for the physical devices for the program could come from the general expense accounts, state and federal grants, or bond issues (Edwards, 2014, p. 1). “Spending for items such as textbooks, workbooks, maps, globes, calculators, and reference books will decrease as these items will all be part of the digital world that all students will have access to” (Edwards, 2014, p. 1).

Implementation of learning activities using technology devices has been commonplace in today’s classrooms. “Regardless of the type of device used in the classroom, availability of the device is very important in helping teacher decide whether or not to use it in the classroom” (Kaur, 2020, p. 32). Teachers no longer needed to check out a cart of laptop computers or walk down to the computer lab for students to get screen time. Along with access to technology devices, software platforms have also transformed. “Google started out as just a search engine, but today it offers many more potentially transformative tools” for fostering learning and student engagement (Smith & Mader, Enhancing Google Sheets for the Classroom, 2017, p. 8). Personal technology devices differed from school to school, district to district.

Lowther, Inan, Ross, and Strahl (2012) conducted a study of the Michigan one-to-one initiative schools in order to determine the impact of laptops for every student (Lowther, Inan, Ross, & Strahl, 2012). Students in one-to-one schools had significantly more technology as a learning tool, opportunities for research, and project-based lessons (Lowther et al., 2012, p. 10). On the other hand, control (non-laptop) schools had significantly more higher-level questions, hands-on experiences, sustained reading, ability groups, and work centers (Lowther et al., 2012, p. 10).

Teachers in the 1-to-1 initiative schools overwhelmingly indicated that they thought “laptop use has a positive impact on student learning and achievement,” and that their instruction was more student centered and interactive. (Lowther et al., 2012, p. 16). Students in the program also had positive responses: 90% indicated that they wanted to use one-to-one laptops the next year, 68.8% indicated their internet skills has improved, and 59.6% indicated that laptops made learning more interesting (Lowther et al., 2012, p. 17). While “students reported that the laptops helped them learn more and made them more interested in learning,” no significant difference was found on state achievement level tests (Lowther et al., 2012, p. 27). Technology integration provided students with positive 21st century skills and abilities while only having a moderate impact of academic results (Lowther et al., 2012, p. 27).

The introduction of the computer into public education challenged traditional teacher practices. “Putting a device in the hands of every student to personalize learning requires teachers to relinquish control and prepare students for more responsibility and choice” (Pautz, Elmendorf, & Mullenax, 2015, p. 7). The teacher’s role may shift in a 1:1 classroom; from the sage on the stage to the coach or facilitator. When a teacher acts as a coach, “they promote creativity and innovation while empowering students to own their learning” (Neebe & Roberts, 2015, p. 33). Marcinek stated in his 2015 one-to-one roadmap, “There’s a big difference between a school that ‘has technology’ and a school that ‘leverages technology to impact teaching and learning and uses data to drive its future purchases and initiatives” (Marcinek, 2015, p. 5).

Westen and Bain (2010) claimed that one-to-one computer initiatives do not reach a higher order of learning. “What does exist are replacements: books replaced by web pages, paper report cards with student information systems, chalkboards with interactive whiteboards, and filing cabinets with electronic databases” (Westen & Bain, 2010, p. 10). “Research suggest that most 1:1 computer programs have shown mixed to modest gains in students’ achievement” (Machado & Chung, 2015, p. 44). Many programs “expect the technology to automatically improve students’ achievement instead of expecting teachers to integrate the computers in ways that promote cooperation, learning differentiation and problem-based learning” (Westen & Bain, 2010). With the use of educational technology, each student can have learning experiences that provide them with positive, tangible, social and academic outcomes (Westen & Bain, 2010, p. 13).

According to Machado and Chung (2015), "The skill of positive technology integration is a growing need for public school teachers. Many teachers currently do not have the technological fluency to accomplish the goals of the new national standards" (Machado & Chung, 2015, p. 43). Regardless of technology skills, "a teaching method that does not work will continue to not work with or without a computer" (Machado & Chung, 2015, p. 44).

Increased student use of technology has occurred in all facets of life. "Growing up in an intensive environment of television, movies, and video games, younger students have developed learning styles where comprehension occurs largely through visual images" (Jackson et al., 2011, p. 294). According to Jackson, Helms, Jackson, and Gum (2011), educators would expect that "students raised in an environment in which senses are flooded with visual inputs may have different expectations regarding what they consider optimal pedagogies for learning and whether they consider technology enhancements a nicety or a necessity" (Jackson et al. 2011, p. 294). With new media consisting of quick soundbites and snippets to grab attention, educators "need to know the changes in young audiences' informative habits to calibrate the scope and effects of digital convergence" (Condeza, Bachmann, & Mujica, 2014, p. 56). The potential for 1:1 programs to align curriculum, pedagogy, and technology-enhanced delivery existed (Jackson et al., 2011). Jackson et al. (2011) stated that "educational institutions have not yet realized the full potential, and that although some of the aspects of educational delivery have indeed changed, with the growth and proliferation of technology course content and objectives have remained the same" (Jackson et al., 2011, p. 295). "Like most interventions, the reality may be that one-to-one laptop programs are only as effective or ineffective as the schools that adopt them" (Goodwin, 2011, p. 78). One-to-one programs can amplify what is already going on in the classroom, school, or district (Goodwin, 2011, p. 79).

For teachers and students, learning to adjust to technology in education is an important component of modern school. Lei and Zhao (2008) stated "one-to-one laptops have provided great opportunities and resources for teaching and learning, but also raised issues such as student discipline problems, concerns or digital literacy, and fear of over-dependency on information technology" (Lei & Zhao, 2008, p. 97). In the one-to-one school observed for their study, students performed a variety of tasks and "used the digital tools to solve many daily problems, including doing homework, searching for information on school work, communicating with friends, developing personal interest, exploration, and having fun" (Lei & Zhao, 2008, p. 117). Results from the study pointed to enriched learning experiences, increased open-ended opportunities, and a significant increase in technology proficiency for students (Lei & Zhao, 2008, p. 117). Use of computer labs or classroom technology, "cannot give students the 24/7 access they need to become operationally adept with digital resources" that is provided by one-to-one programs (Livingston, 2009, p. 66).

Zheng, Warschauer, Lin, and Chang (2016) produced a meta-analysis on one-to-one learning environments. Findings included that "both teachers and students indicated that having access to online resources expanded students' motivation and interest" (Zheng et al., 2016, p. 1074). According to Holcomb (2009) "In general, laptop programs are viewed in a favorable light. A great deal of research has highlighted and documented the educational gains as a result of 1:1 learning" (Holcomb, 2009, p. 52). A positive impact appeared in several studies that specified improvement for disadvantaged students (Zheng et al., 2016, p. 1074). “In comparison with high-socioeconomic status (SES) peers, low-SES students gain more technological proficiency from laptop environments, presumably because they started with less experience with digital media outside the classroom” (Zheng et al., 2016, p. 1074). The laptop programs contributed to shrinking the gap in achievement between low-income students and those with a higher socioeconomic status (Zheng et al., 2016, p. 1075).

The International Society for Technology in Education (ISTE), developed standards for both students and educators as a way “to rethink education and create innovative learning environments” (ISTE-International Society for Technology in Education, 2019). Table 1 identifies seven standards for consideration; such as, an empowered learner, digital citizen, knowledge constructor, designer, computational thinker, creative communicator, and global collaborator. These standards can be incorporated into student technology courses, or imbedded in general education classes.

Table 1

ISTE Standards for Students

ISTE Standards for Students	Explanation
Empowered Learner	Students set their own goals and strategies and leverage technology to seek feedback and improve their practice
Digital Citizen	Students recognizes rights, responsibilities and opportunities of learning and working in an interconnected digital world
Knowledge Constructor	Students create resources using digital tools to construct knowledge, produce artifacts and making meaningful learning experiences for themselves and others
Innovative Designer	Students use technologies in a design process to identify and solve problems and exhibit a capacity to work with open-ended problems
Computational Thinker	Students use technology assisted strategies to analyze data, construct models, use algorithms and establish automated systems
Creative Communicator	Students communicate clearly and express themselves creatively using tools, platforms, and digital media appropriate for their goals
Global Collaborator	Students use digital tools to collaborate effectively as a team with others locally and globally

Note: Source: ISTE-International Society for Technology in Education (2016).

Blended Learning

According to Aslan and Reigeluth (2013), "the only way to significantly improve education and training is to transform the teacher-centered, standardized paradigm founded on time-based student progress to the learner-centered, customized paradigm founded on attainment-based student progress" (Aslan & Reigeluth, Educational Technologists: Leading Change for a New Paradigm of Education, 2013, p. 24). Marcinek (2015) stated "Technology should not stand out; it should blend with dynamic teachers and the engaging curriculums they design" (Marcinek, 2015, p. 93). Holcomb

(2009) argued that integrating technology, as opposed to just giving the students laptops was the pathway toward improving achievement (p. 52). Infusing technology into content lessons allowed for teacher effect with aligning curriculum and helping students to mastery the learning standards (Holcomb, 2009, p. 52).

Blended learning is a combination of part-time online learning, with elements of self-pacing and individual student control, and part time supervised instruction in a classroom (Tucker, Wycoff, & Green, 2017, p. 6). Computer-assisted instruction was a major component of technology-based teaching and learning (Ross, Morrison, & Lowther, 2010, p. 19). Teachers facilitating blended learning may use a station-rotation system. “While students are learning via digital curriculum, the teacher is stationed at the direct instruction or conference station. Other students are at the hands-on or project-based learning station” (Tucker et al., 2017, p. 75). Through blended learning, students are able to take ownership of their learning and be respectful to the greater community as digital citizen (Tucker et al., 2017, p. 9). Some valuable uses of a technology station include providing practice or remediation on core content skills, providing enrichment opportunities for students “in a different way to promote higher-order levels of learning”, and increased exposure to questions in order to increase fluency (Ross et al., 2010, p. 20).

Flipped Classrooms

While there are a variety of styles for producing a flipped classroom, all have the same general principle:

> Direct instruction is blended with constructivist learning pedagogies so that individualized differentiated learning is facilitated. Learning is not limited to the classroom, and students can move at their own pace and direct their efforts based

> on their own individual needs, thus personalizing instruction. Students are expected to take responsibility for their own learning. The teacher's role as a course designer shifts somewhat from structuring in-classroom time to providing learning resources that can be consumed asynchronously as needed. (Davies, Dean, & Ball, 2013, p. 565)

The strategy of flipping a classroom has become increasing available for teachers to use due to the increase in technology and devices (Davies et al., 2013, p. 564). However, the goal of a good lesson remains connected to student learning and applications of their learning (Davies et al., 2013, p. 564). ”Flipping a boring lecture from the classroom to the screen of a mobile device might save instructional time, but if it is the focus of our students' experience, it's the same dehumanizing chatter just wrapped up in fancy clothes" (Musallam, 2017, p. 101). However, a plethora of open educational resources are available through the internet that provide students with high quality lessons, often designed by experts in order to support learning (Marcinek, 2015, p. 96). According to the research of Sergis, Sampson, and Pellicone (2017), utilizing a flipped classroom model has statistically and significantly higher levels of cognitive learning outcomes, overall motivation, increased academic performance and levels of satisfaction (Sergis, Sampson, & Pelliccione, 2017, p. 376).

Davies, Dean, and Ball (2013) found that teachers typically go too fast for some students and too slow for others. "The flipped approach allows students to pace themselves through the subject material" (Davies et al., 2013, p. 577). Duhaney (2012) stated, "With blended learning, students believe that they have more control over the pacing of the course and where they wish to engage in their learning" (Duhaney, 2012, p.

199). In addition, "flipped materials, particularly the set of instructional videos, created for the flipped approach, were as effective at motivating students about the subject matter as the instructors delivering the regular approach" (Davies et al., 2013, p. 578).

Teachers and students were no longer comfortable with learning in a passive setting that is still largely text-based and heavily dependent on the lecture format," (Duhaney, 2012, p. 199) Christensen et al. (2011) described two stages of technology disrupting traditional teaching and learning through online education. The first stage was computer-based or online learning linked with specific software (Christensen et al., 2011, p. 91). "The second phase of this disruption we term student-centric technology, in which software has been developed that can help students learn each subject in a manner that is consistent with their learning needs" (Christensen et al., 2011, p. 92). Students could get access to online tutors and resources that were previously out of reach due to economic constraints (Christensen et al., 2011, p. 92).

Massive Open Online Courses (MOOCs) provided students with the ability to follow their personal interests and passions. "Many of the pioneers of open movements have come from universities. The core functions of academics are all subject to radical change under an open model" (Weller, 2014, p. 2). MOOCS contributed to challenging traditional publications as well as traditional institutional norms for higher education (Weller, 2014). "The idea behind MOOCs is simple: make online courses open to anyone and remove the costly human support factor" (Weller, 2014, p. 6). Flipped classrooms provided both teachers and students with viable, alternative options to the traditional classroom setting.

Teacher Professional Development

Aslan and Reigeluth (2013) stated that research indicated, "Teachers tend to refuse to use technology" because they do not see the technology as transformative (Aslan & Reigeluth, 2013, p. 23). While the method is the same, the medium may be different (Aslan & Reigeluth, 2013, p. 23). "Instead of chalkboard we suggest using a Smart Board; instead of a printed book, an E-book; and instead of a paper-pencil test, an online test" (Aslan & Reigeluth, 2013, p. 23). When "new technology s introduced in any field of practice, it is typically used to support the prevailing methods in that field. Gradually over time people recognize that it can be used to create methods that were previously not feasible" (Reigeluth & Joseph, 2002, p. 9).

"Change in structure alone is unlikely to produce vast improvement" (Horn, 2013, p. 78). As facilitators of transformational learning, as one-to-one programs are dispersed throughout the United States, it is essential for teachers to be a leading focus in the revolution. "The successful use of computers in learning will depend largely on the attitudes of teachers and their willingness to embrace the technology" (Teo, Lee, & Chai, 2008, p. 128). According to Papert (1993):

> The central practical problem is to find ways in which teachers who are at different places in the willingness to work for change can do so. There cannot be a uniform change across the board-any attempt to do that will reduce the pace of change to that of the least common denominator. Society cannot afford to keep back its potentially best teachers simply because some, or even most, are unwilling. (Papert, 1993, p. 81)

Each year, teachers met with new groups of students, as well as new programs, initiatives and mandates. “Professional development is often overlooked or underfunded during the planning phase, so this chapter is a must-read for all program planners and administrator” (Livingston, 2009, p. 78). Proper training and buy-in was crucial for a one-to-one program to succeed. “The effective use of technology enables teachers to facilitate and adjust their instructional strategies to optimize students’ learning” (Teo et al., 2008, p. 128). According to Peggy Ertmer (2012), “There are a number of different types of supports needed for effective integration including administrative, technological, professional, and peer” (Ertmer, 2012, p. 425). Marcinek (2015) declared “the best device a school can roll out is a teacher who can adapt to new and emerging technologies, does not always require formal training for learning and staying current, and is not tethered to a product” (Marcinek, 2015, p. 79). Holcomb (2009) stated, “Teachers must adjust and redesign their instructional practices if they are going to successfully integrate the use of 1:1 computing teaching and learning practices while also staying aligned with the curricula and standards” (Holcomb, 2009, p. 53). Teacher connection between the new technology skills and classroom/lesson application is critical for successful program realization (Holcomb, 2009, p. 53).

According to Collins and Halverson (2009), schools were designed around the architype of the teacher as the expert and gatekeeper of knowledge (p. 44). Educational technology, on the other hand, provides students with various sources, platforms, and experts in which to gain knowledge and gather information (Collins & Halverson, 2009, p. 44). “The goal for any effective technology professional development program should be to provide teachers with the opportunity to use technology and to become familiar with ways in which to integrate technology into their classrooms" (Frei, Gammill, & Irons, 2007, p. 179). "While students will still be able to do meaningful work with their laptops, their experience in the classroom won't change very much if teachers don't embrace the new technology" (Livingston, 2009, p. 93). One-to-one programs required a "new role for the teacher: that of facilitator and coach. Replacing the traditional model of a teacher as a lecturer, the teacher instead presents students with challenging real-life problems and the technology tools to solve them" (Frei et al., 2007, p. 13).

Whitaker, Casas, and Zoul (2015) supported educators reaching out to form networks of learning. The internet had a plethora of resources and supporting content to allow teachers to individualize their professional development needs concerning technology integration. Social media, especially Twitter, "gives you the opportunity to expand your knowledge, which leads to more opportunities to teach others what you have learned and allow you to make an even greater impact on others than you ever thought possible" (Whitaker, Casas, & Zoul, 2015, p. 8).

According to McKenzie (1999), the one-size-fits-all approach for adult learning does not work. "Staff development is all too often what we DO TO teachers. It sets up a parent-child relationship – often inspiring resistance and resentment rather than growth" (McKenzie, 1999, p. 67). Providing adult learners with choice was a key concept and allows for the incorporation of preferences, interest, and styles (McKenzie, 1999, p. 67). Topper and Lancaster (2013) suggested, "While traditional, after-school and summer in-service workshops are helpful for many teachers and clearly provide required technical expertise, they may be insufficient for most teachers engaged in technology integration initiatives" (p. 348). Kaur (2020) indicated that specific professional development encompassing relevant applications add to student learning, differentiated instruction, and a community of collaboration. School districts that do not plan for or provide explicit time for professional development were not likely to see high yield usage or maximized student benefits (Topper & Lancaster, 2013, p. 354). By “providing intense, sustained teacher-focused PD with opportunities for exploration, reflection, collaboration, work on authentic tasks, and engagement in hands-on, active learning,” districts could quantify success (Topper & Lancaster, 2013, p. 356). “Ongoing targeted professional development, planning, and practicing a new technology is crucial for effective use” (Kaur, 2020, p. 32).

The integration of technology in the classroom would only come about if the teachers are prepared, capable, and confident in their implementation of the information communication media and blended learning strategies (Duhaney, 2012, p. 201). “By embracing the use of blended learning, teacher preparation programs help teacher candidates learn how to tap into their students’ interest and familiarity with a range of information communication, technology to encourage and facilitate an engaging learning environment” (Duhaney, 2012, p. 201).

The ISTE Standards for Educators (2017) highlighted pathways for teachers to serve as both empowered learners and catalysts for learning (ISTE-Internation Society for Technology in Education, 2017). Figure 1 highlights how a student can be empowered as a learner, leader, and citizen and their ability to act online as a collaborator, designer, facilitator, or analyst.

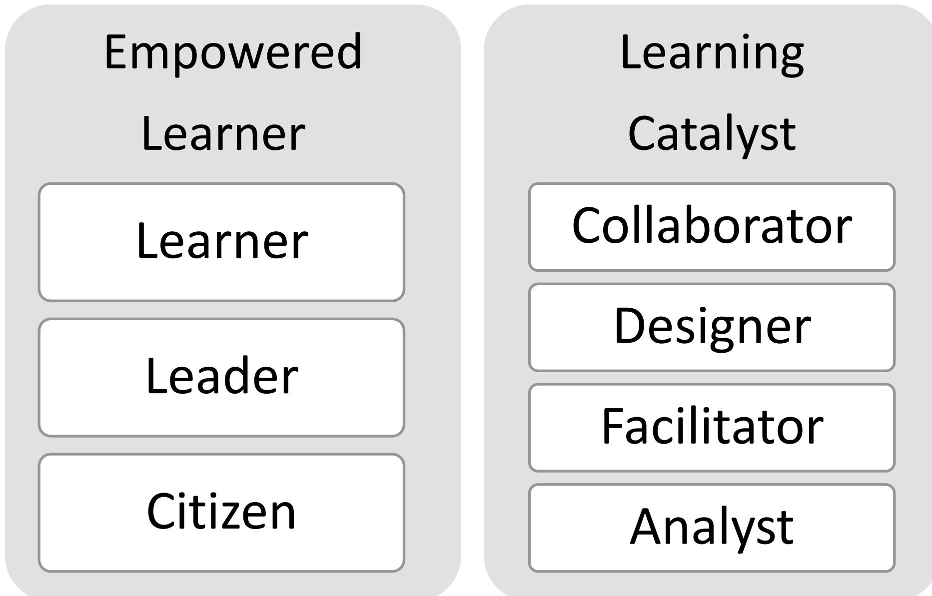

Figure 1. ISTE Standards for Educators (ISTE-Internation Society for Technology in Education, 2017).

Teachers themselves need to be comfortable with the tools and digital concepts before they can help others (Clark & Avrith, 2017, p. 4). Through professional development surrounding technology, teachers can become the catalyst for learning in order for students to reach their digital potential. “Authentic and current professional development for teachers should use blended learning, collaborative learning, and engage in the challenges of the current context” (Ruggiero & Mong, 2015, p. 175). With access to computers and proper training and motivation for students and teachers, technology can serve as a powerful conduit for learning (Kaur, 2020, p. 32).

Best Practices with Educational Technology

Stakeholders in education seek high student growth and achievement as they appropriate funds and allocate resources. “The promise of technology for education lures school districts and states to invest heavily in the newest gadgets—decisions often rash, misplaced and misconceived. The same story is told again and again and again” (Elstad, 2016, p. 150). Computers and technology have been an increasing presence in classrooms across the United States. “No one doubts their growing impact in most aspects of human endeavor, and yet strong evidence of their direct impact on the goals of schooling has been illusory and subject to considerable debate” (Tamim, 2011, p. 5). While new technology has consistently immerged, “comparisons between computing and non-computing classrooms, ranging from kindergarten to graduate school, have been made since the late 1960s” (Tamim, 2011, p. 5).

The amount of technology used in school may be different based on the wants and needs in each community (Horn, 2013, p. 79). The sheer variety of individual education conditions and environments, allowed with the nature of how technology continuously changed and updated, made measuring effectiveness difficult. “The technology of today shortly becomes the technology of yesterday in education” (Ruggiero & Mong, 2015, p. 174). “Attempting to prove the effectiveness of technology through media comparison studies seems rather limited” due to variances and range of instructional strategies (Ross et al., 2010, p. 19). “Technology is ever present in the lives of adolescents” (Fitton, 2013, p. 401). The learning experience created by teachers for students “must be relevant and address the needs of the region and the world now and in years to come; it must be of the highest quality and impart to students the best concepts and the greatest skills” (Haas, 2015, p. 45).

According to Clark (1983), the change in curriculum caused the shift in education and not advancements in technology. (Clark, 1983, p. 445). “Media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers groceries causes changes in nutrition” (Clark, 1983, p. 445). Educational practices remained the key contributor to student learning (Clark, 1983, p. 445). "The history of technology use in education is complex and contentious, but what is clear is that in order to support transformative education practices, technology must be embedded within a pedagogic approach that privileges empowerment and democratic practice" (Mitchell, 2016, p. 4).

For students, use of technology has become more than a method for word processing. According to Cuban and Cuban (2007), "Most students believed that computers opened doors to mainstream society. Not using the machines made them fell they were outsiders," (p. 73). Holcomb (2009) found the students using laptops became better writers overall, regardless of if they used a computer or word processor to complete a writing piece (Holcomb, 2009). "One-to-one computing has had a significant impact on writing scores for students across the country. Part of the reason for this was because student spent more time using their laptops to write, edit, and reflect on their writing" (Holcomb, 2009, p. 50).

Learning experiences facilitated by a classroom teacher have shifted in order to incorporate the digital age. Clark and Avrith (2017) acknowledged, "If we're going to prepare our students for a technology-rich future, we must expand the definition of what it means to be literate. We need to create a disruptive shift in how we, as educators, define literacy" (p. 5). "Though our tech-tuned 21st century students are often more fluent in the use of technology than their parents and teachers, they will always need guidance in how to best apply these powerful tools to complex learning and creative tasks" (Trilling & Fadel, 2009, p. 70). Twenty-first century skills, such as creativity and collaboration, are fostered by applications available through use of technology.

"Accessing, evaluating, applying, and managing information well, and using information sources appropriately and effectively, are just some of the skills that define 21st century digital literacy" (Trilling & Fadel, 2009, p. 66) Teaching strategies, as well as technologic interventions, have been created in order to promote student interest as well as student achievement (House, 2012, p. 345).

Along with the ever-changing modes of technology, educators have had to wrestle with how to handle devices in the classroom. "With technology continuing to become faster, smaller, and cheaper, its place in every classroom is a forgone conclusion" (Hilton, 2015, p. 72). Teacher preparedness for the utilizing technology to enhance technology coincides with experiences and personal knowledge of computers and programs. "The most cited reason for lack of implementation of new technology is lack of professional development" (Ertmer, 2012, p. 425).

One company that has provided a digital platform conducive for 1:1 learning was Google. Starting out as just a search engine, Google offers many more potentially transformative tools (Smith & Mader, Science 2.0: Expanding Google in the Classroom, 2014, p. 8). Google Classroom began as a "servicing platform for schools trying to simplify creating, distributing and grading assignments. This was intended for being a paperless solution in education" (Aquino, 2019). Google Classroom was launched for teacher and student use in August of 2014 (Aquino, 2019). Google has redefined "what learning space looks like, taking the traditional classroom and making it a place where we help our students visualize their thinking, give each and every one a voice, and allow them to share and publish their work" (Clark & Avrith, 2017, p. 3).

Technology Device Usage

Aslan and Reigeluth (2011) developed four periods in the history of computing: The Mainframe Period, Microcomputer Period, Internet Period, and Personalized Computing Period (p. 1). During the late 1950s through the late 1970s, large mainframe computers defined the Mainframe Period (Aslan & Reigeluth, 2011, p. 3). In addition, mini computers that served a purpose for programming, computer-assisted instruction, basic drill practice and tutorials were available (Aslan & Reigeluth, 2011, p. 5).

The "Microcomputer Period" from the late 1970s until the end of 1990s introduced the personal computer into homes, businesses, and schools (Aslan & Reigeluth, 2011, p. 6). Advanced drill and practice and tutorials, intelligent tutoring systems, spreadsheets, database management systems, and drawing tools all become available for individuals (Aslan & Reigeluth, 2011, p. 11). "These machines gained popularity among parents, teachers, students, and administrators. Several versions of microcomputers were introduced with different capabilities" (Aslan & Reigeluth, 2011, p. 8). In 1984, Apple released the Macintosh Computer for under $2500, with "mouse-window-desktop technology" (Williams, 1984, p. 30). Once people had access to computers, they were able to increase their technological literacy (Aslan & Reigeluth, 2011, p. 6). "In this Microcomputer period, several projects and programs were designed to facilitate computer use in the schools. The IBM Secondary School Computer Education Program and Apple Classroom of Tomorrow were two of the most important projects during these years" (Aslan & Reigeluth, 2011, p. 7). By the 1990s, "word processing applications were a predominant form of computer use among students in this period because students could finish their work more easily than using pen and paper, and they could change the text easily" (Aslan & Reigeluth, 2011, p. 7).

The 2000s brought about the "Internet Period" (Aslan & Reigeluth, 2011, p. 8). This period included networked-personal computers and portable computers (laptops and handhelds), and allowed for collaborative digital tools, personal broadcasting, learning management systems, and data management systems (Aslan & Reigeluth, 2011, p. 11). Teachers and textbook companies no longer were the sole distributors of content, thus the teacher could slide into a facilitator of learning role opposed to the sage on the stage (Aslan & Reigeluth, 2011, p. 9). With the advent of wireless technology, schools found it easier and less expensive to adopt this emerging technology" (Aslan & Reigeluth, 2011, p. 9).

Aslan and Reigeluth identify the fourth period as the "Personalized Computing Period" (Aslan & Reigeluth, 2011, p. 12). "With the advent of wireless technology, schools found it easier and less expensive to adopt this emerging technology" (Aslan & Reigeluth, 2011, p. 9). Aslan and Reigeluth (2016) identified a learning management system "some call a Personalized Integrated Educational System (PIES) to facilitate learning," (Aslan & Reigeluth, 2011, p. 13). According to Aslan and Reigeluth (2016), there are four major functions of PIES: recordkeeping, planning, instruction, and assessment (Aslan & Reigeluth, 2016, p. 1109).

With a growing number of programs throughout the country, determining what type of device will best serve the students is a crucial component in planning a program. Portable devices, such as laptops, tablets, and smartphones, offer different benefits and had different costs. "With the changes in the requirements of technology skills in education, and development of innovative technological devices such as Chromebooks and iPads, use of technology in the classroom has come a long way" (Kaur, 2020, p. 26). These devices support advancements in 21st century thinking, but also pose some challenges. "Successful implementation depends on the adequate availability of the resources, familiarity with the device and more support from administration in the form of specific training on how to use the device effectively to support student learning" (Kaur, 2020, p. 33).

The launch of a one-to-one program requires intricate planning, preparation and collaboration (Holcomb, 2009, p. 53). "How and when laptops are distributed can play a key role in determining the success of a 1:1 initiative" (Holcomb, 2009, p. 53). Providing adequate technology training for teachers and staff prior to students receiving devices is preferable so that teachers have the opportunity to practice and become used to the new technology (Holcomb, 2009, p. 53). "Hosting parent nights as part of the distribution process has also been found to be an effective component associated with the deployment of student laptops" (Holcomb, 2009, p. 53).

Depth of Knowledge

Depth of Knowledge, or DOK, referred to the term coined by Webb (2002), and depicted the level of thought required for students, as developed in curriculum, standards, and assessments. As a component used for standardized testing, the advent of DOK "compelled states to rethink the meaning of test alignment to include both the content assessed in a test item and the depth to which we expect students to demonstrate understanding of that content" (Hess, Jones, Carlock, & Walkup, 2009, p. 4). Paige, Sizemore, and Neace (2013) indicated school leaders had shifted from evaluating only a teacher's demeanor, management, and pedagogy, but also the depth of knowledge required for students in lessons, activities, assessments, and discussions within the class (Paige, Sizemore, & Neace, 2013). Leaders push to identify and categorize cognitive rigor observed in classrooms (Paige et al., 2013). Hess, Jones, Carlock, and Walkup (2009) stated, "Students learn skills and acquire knowledge more readily when they can transfer their learning to new or more complex situations, a process more likely to occur once they have developed a deep . . . understanding of content" (Hess et al., 2009, p. 6). In order to "change learning outcomes, they must have evidence that students are being challenged to think at high levels. We propose that the extent to which students are challenged to think at high levels is a reflection of the cognitive rigor taking place" (Paige et al., 2013, p. 105). Table 2 delineates the types of learning activities and key words associated with each level of DOK.

Table 2

Depth of Knowledge

Depth of Knowledge Level	Key Words	Examples
Level 1	Recite, recall, report, state, use, name, label, list, match, tell, memorize, quote	• Items that are based on memorization • Single-Step math problems • Reading Comprehension
Level 2	Infer, categorize, collect and display, identify patterns, organize, construct, modify, predict, Estimate, compare, summarize	• Finding indirect information • Two-Step math Problems • Involve some cognitive processing
Level 3	Revise, assess, compare, differentiate, investigate, cite evidence, hypothesize, formulate, draw conclusions	• Items that require reasoning and support evidence • Analysis of an argument • Justification of solution to math problems. •
Level 4	Design, connect, synthesize, apply concepts, critique, analyze, create, prove	• Planning, Research, and Problem Solving • Reaches multiple perspectives and requires effective communication and presentation of ideas • Projected-based, multifaceted • An authentic product is created

Note: Compiled from information provided by Herman and Linn (2014) and Webb (2006).

Rigor in Education

"In all cases, we should not focus our decisions on technology but on methods that will best facilitate learning" (Reigeluth & Joseph, 2002, p. 11). The question of whether students were receiving a rigorous education in American public schools increased over the past several decades (Blackburn & Williamson, The Characteristics of a Rigorous Classroom, 2009, p. 2). According to Ainsworth (2010), in many regions throughout the U.S., people perceive a decrease in the rigor of student learning (p. 6). “Only when you create a culture of high expectations and provide support so students can truly demonstrate understanding do you have a rigorous classroom,” (Blackburn & Williamson, 2009, p. 2). There are a variety of perspectives in the educational field as how to define and establish rigor in the classroom.

Wagner (2008) placed an emphasis on rigor as being skills applicable for success in the 21st century. “Excellent instruction” Wagner stated, “is not a checklist of teacher behaviors and a model lesson that covers content standards,” (Wagner, 2008, p. 24). Wagner enumerated areas in which rigor is defined through life skills relevant for 21st century students (Wagner, 2008). According to Ainsworth (2010), rigor involves “the ways in which students apply their knowledge through higher-order thinking skills; it also implies the reaching for a higher level of quality in both effort and outcome” (Ainsworth, 2010, p. 6).

A major component of critical thinking and problem solving is the ability to ask questions in a way that pushed people to rethink and think anew (Wagner, 2008, p. 21). “Yesterday's answers won't solve today's problems" (Wagner, 2008, p. 21). According to Musallam (2017), providing students with time for productive struggle and “embracing the mess” of learning is a powerful piece to the promotion of critical thinking (p. 56).

> The practice of waiting , , , does not negate or challenge the need for direct instruction. Rather it forces you to be more intentional about deciding when direct instruction is applied. This paradigm shift leverages lecture as ‘spackle’ rather

> than 'paint'—identifying and filling in gaps in knowledge, rather than viewing students as a blank canvas. (Musallam, 2017, p. 59)

Other components in the area of rigor were collaboration and leadership. Teamwork is no longer just about working with others in your building. Technology has allowed teams to work on projects as teams across the planet (Wagner, 2008, p. 21). Students may not be equipped or capable in terms of leadership abilities (Wagner, 2008). "Kids just out of school have an amazing lack of preparedness in general leadership skills and collaborative skills" (Wagner, 2008, p. 21).

Agility and Adaptability requires students to "think, be flexible, change, and use a variety of tools to solve new problems" (Wagner, 2008, p. 22). When employers look at hiring for positions, they understand that jobs may represent roles and expectations may change in response to technology. Wagner (2008) noted that it is integral to employee individuals who can change and adapt within a market in order to succeed.

It is key to "create a culture of high expectations and provide support so students can truly demonstrate understanding" in a rigorous classroom (Blackburn & Williamson, The Characteristics of a Rigorous Classroom, 2009, p. 2). According to Bogess (2007), "it is the quality of thinking, not the quantity that defines rigor" (p. 62). Bogess specified a definition of rigor:

> One definition of rigor is 'difficulty', but just because something is difficult does not mean that is meets that test of reflective thought. It is possible to present students with questions that are difficult but require only simple recall answers. Likewise, merely adding to the length of assignments may make them more difficult, but this is not what is expected in rigor. Academic rigor is learning in

> which students demonstrate an in-depth mastery of challenging concepts through thought, analysis, problem solving, evaluation or creativity. (Bogess, 2007, p. 62)

Blackburn (2018) surmised "the heart of authentic rigor is learning, not punishment. It is about growth and success, not failure" (Blackburn, Rigor is Not a Four Letter Word, 2018, p. 13). The push for productive struggle in order to increase learning and understanding coupled with high engagement is crucial for the success of any modern educational curriculum and program. Ainsworth believes the "broader definition of 'rigor' must include the intentional inclusion of and alignment between all necessary components within the curriculum" (Ainsworth, 2010, p. 7).

Engaging Students

Public education has focused on how learning can be relevant to students. "While students are required to fit into a restrictive school structure, culture, and curriculum, schools do little to fit themselves to their students" (Washor & Mojkowski, 2014, p. 8). With one-to-one computers, teachers are able to utilize updated, relevant material through open educational resources found on the internet in order to combat a dated textbook (Marcinek, 2015, p. 96). "Engagement is the holy grail for teachers, an almost mythical, nirvana-like state that we achieve in our classrooms when all the elements fall into place perfectly" (Neebe & Roberts, 2015, p. 36). These elements include the right activity, timing, and student groupings (Neebe & Roberts, 2015, p. 36).

Student expectations and accountability are key components for a practical and engaging learning environment. School systems strive to hold students to high expectations in order to push student learning to a high level. "Just as schools have high expectations for students, young people have high expectations for schools" (Washor &

Mojkowski, 2014, p. 8). Washor and Mojkowski (2014) identified 10 expectations that students have for schools (p. 9). The expectations were listed as relationships, choice, authenticity, relevance, time, application, play, challenge, practice, and timing. All of these “expectations capture what (students) consider essentials for a student learning experience” (Washor & Mojkowski, 2014, p. 10).

Students reported that they are more likely to engage when “they have caring teachers who create active learning opportunities” (Neebe & Roberts, 2015, p. 37). Within a one-to-one classroom, the opportunity exists to “transition from the old paradigm in which one student would participate at a time to a new normal in which everyone does the thinking and everyone contributes to the learning” (Neebe & Roberts, 2015, p. 37). Neebe and Roberts (2015) indicated that a one-to-one classroom is a conducive environment for facilitating high engagement because it charges students with three key conditions: “connection, perplexity, and curiosity” (Neebe & Roberts, 2015, p. 37).

Hattie (2009) indicated that feedback is one of the most powerful instructional strategies that has a considerable positive effect size. Connecting learning activities and achievement in a low-risk environment can allow a student to “engage proactively with feedback” to improve performance (Cutumisu & Schwartz, 2018, p. 364). Teachers can “create connections for our students within the classroom and beyond” utilizing digital tools and interactive platforms (Neebe & Roberts, 2015, p. 37).

Students can be inspired to strive for a deeper understanding of their learning (Neebe & Roberts, 2015, p. 38). Perplexity is the process of being interested in something a person does not know about yet, but would like to investigate, believing he/she has the tools to find out (Meyer, 2014). Educators can "foster perplexity by starting with a specific and interesting problem to explore and providing the right amount of modeling, scaffolding, and confidence building to help students solve it" (Neebe & Roberts, 2015, p. 38).

Teachers can promote students' curiosities by "providing breadcrumbs of information that will encourage them to follow the path of knowledge" (Neebe & Roberts, 2015, p. 38). In a one-to-one environment, teachers facilitate curiosity when they "introduce digital tools that cater to their unique passions and interests" (Miller, 2015, p. 24). As stated by Musallam (2017), "once curiosity is piqued, our minds are strengthened, connections are made, and awareness is enhanced" (p. 12). The emotion of being curious is more than just a gap in information; it is intense anticipation of cognitive clarity (Musallam, 2017, p. 12).

Connecting with students' curiosities and providing structures for perplexity is a tool to push rigor in a 1:1 classroom (Neebe & Roberts, 2015, p. 38). Forging teacher-student relationships connects and engages. While working within a task "perplexity focuses on solving a problem with the tools you have" (Neebe & Roberts, 2015, p. 38).

Engagement comes from applying knowledge and creating products for the real world. "As students seek to access more information through technology, they are able to deepen their knowledge so that they can meet their own personal needs and interest" (Firmin & Genesi, 2013, p. 1604). As concluded by Musallam (2017), if "educators leave behind this simple role as disseminators of content and embrace a new paradigm as cultivators of curiosity and inquiry, we just might bring a little bit more meaning to their school day and spark their imagination" (Musallam, 2017, p. 97). According to Aslan and Reigeluth (2013),

> Students can be involved in designing their own projects or they can be allowed to choose from among a wide variety of projects that all require the same competencies, so that what the students work on is aligned with their interests, career goals and passions. This potentially increases students' motivation by reinforcing ownership of learning and triggering the relevance piece of learning. (Aslan & Reigeluth, 2013, p. 20)

One element of engaged learning is prescribing activities that have relevance and meaning outside of the academic context (Conrad & Donaldson, 2011, p. 92). An authentic activity allows students to pull ideas from their prior experiences in order to visualize, problem solve, and collaborate in a way that mimics a real life situation (Conrad & Donaldson, 2011, p. 93). "The ultimate goal is to build lifelong learners who can take advantage of opportunities to apply knowledge and skills gained in their courses and identify new knowledge that they need to develop in the future" (Conrad & Donaldson, 2011, p. 93).

Recognizing that education has shifted to a learner-centered paradigm, the mindset of a "one size fits all' education system is no longer relevant (Aslan & Reigeluth, 2013, p. 19). "In an educational system for the information age, instruction is a part of project-based learning, which encompasses all hands-on active learning instructional methods including problem-based learning, case-based learning," and student inquiry (Aslan & Reigeluth, 2013, p. 19).

SAMR

SAMR is the acronym used for identifying the impact level of technology used during a classroom lesson (Puentedura, 2009). “Gaining popularity in late 2012, Dr. Ruben Puentedura’s SAMR model provides a framework for teachers designed to improve the integration of emerging technologies” within a variety of educational contexts (Hilton, 2015, p. 68). From lower to higher, the levels of SAMR are Substitution, Augmentation, Modification, and Redefinition (Puentedura, 2009).

Puentedura suggested that teams take the model and “create rough SAMR ladders” in order to take a unit of instruction and practicing moving up the ladder from Substitution to Augmentation to Modification to Redefinition. This practice of scaffolding to higher levels of SAMR improves student outcomes and enhances learning experiences (Puentedur, 2016).

At the lower levels of SAMR, educators used technology to substitute or augment without a functional adjustment to influence the student learning experience (Puentedura, 2016). “What does exist are replacements: books replaced by web pages, paper report cards with student information systems, chalkboards with interactive whiteboards, and filing cabinets with electronic databases. None of these equivalents addresses the core activity of teaching and learning” (Westen & Bain, 2010, p. 10).

SAMR, used as a lens to determine the how and why of technology use, increases student outcomes (Puentedura R. , 2016). As students work up the levels of the SAMR ladder, both comprehension and application of skills improve (Puentedura R. , 2016). At the modification level, a significant redesign that requires technology occurs (Puentedura R. , 2016). For example, a computer simulation with which students interact to see light traveling would be a modification compared to a picture diagram (Hamilton, Rosenberg, & Akcaoglu, 2016, p. 435). “As a taxonomy, the SAMR model represents the idea that teachers more effectively use technology when they enact modification or redefinition, rather than substitution or augmentation” (Hamilton, Rosenberg, & Akcaoglu, 2016, p. 437).

Others have challenged the notion of technological impact on learning and achievement. Cuban (2001) questioned how educational technology has truly influenced teaching and learning (p. 178). While “far from the project-based teaching and learning that some techno-promoters have sought,” teachers use “new technology basically to continue what they have always done: communicate with parents and administrators, prepare syllabi and lectures, record grades, and assign research papers” (Cuban, 2001, pp. 178-179). Westen and Bain (2010) commented on the field of education pushing technology tools out in mass in hopes of achieving spontaneous positive benefits to learning as a result (p. 10). “In other fields, this has not been the case. Form and function of usage have driven access to computers, not vice versa. Educators should think similarly” (Westen & Bain, 2010, p. 10).

Puentedura (2016) claimed that technology frameworks like SAMR provided an increase in “peer mentorship” as students learned from each other on the higher rungs of the SAMR ladder. Figure 2 displays the ladder and differentiates between levels of enhancement and transformation.

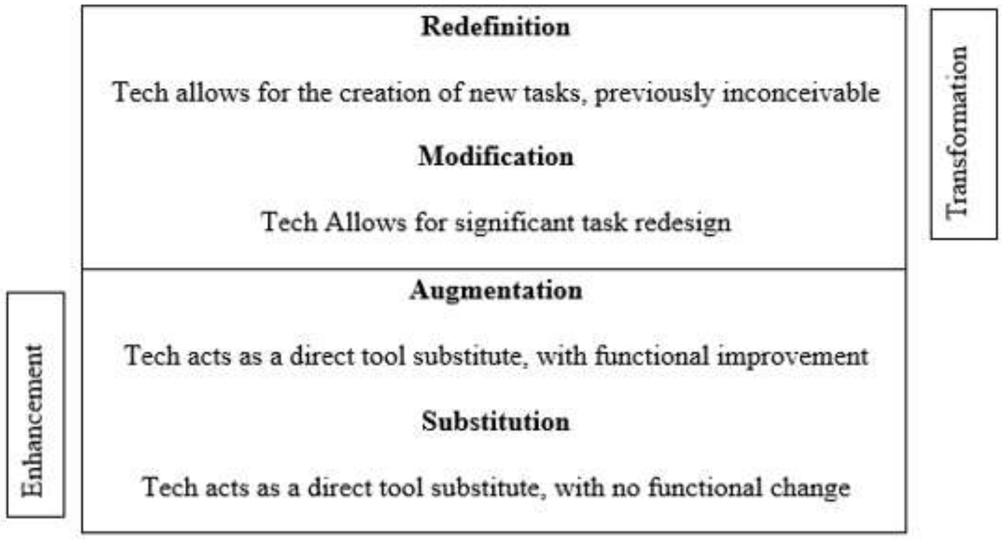

Figure 2. A visual Representation of the SAMR Ladder. (Puentedura, 2009)

According to Miller (2015), Puentedura "puts substitution and augmentation in the 'enhancement' group, and puts modification and redefinition in the 'transformation' group" (Miller, 2015, p. 73). While enhancing lessons benefits student learning and engagement, to reach the redefinition level, a "task was previously inconceivable without technology" (Miller, 2015, p. 73). Lei and Zhao (2008) provided the example of students in a social studies class going online to comment, voice opinions, interact with peers, critique and be critiqued (p. 109). "These experiences challenged students to think critically about their peers' work and their own; and as the teacher pointed out, it hopefully would increase student's abilities to 'accept criticism and be responsible for their thoughts'" (Lei & Zhao, 2008, p. 109).

> Students used their laptops to communicate with and connect to their friends via email, Instant Messengers, chat rooms, discussion boards, and blogs. In addition

> to written messages, their emails often included file attachments containing schoolwork, a URL of a cool Website, a nice song that they wanted to share with their friends, pictures they took over a trip, and sometimes even short voice messages transferred via email. Instant messages included many "emoticons" to express their feelings and emotions more accurately and dramatically than words alone, and they used Flash animations to dramatize the conversation. (Lei & Zhao, 2008, p. 110).

Students can use technology as a multifaceted interface to a global community. With open and interactive platforms like Twitter, Blogs, Pinterest, *YouTube*, Facebook, Snapchat, Instagram, and other social media, students are able to reach an authentic audience and communicate thoughts, ideas, or other media sources in ways that would not be conceivable without technology (Clark & Avrith, 2017, pp. 108-111)

Computer availability for students allows teachers to create innovative lessons that would not otherwise be possible, or simply to adopt existing lessons into the technological realm (Kent & McNergney, 1999, p. 37). Chambré (2017) stated, "I use Google Docs during writing because the comment and chat features allowed for synchronous and asynchronous conversations, a feature not found in Microsoft Word or a writer's notebook" (p. 497). Technological advantages, such as Google Docs, allow teachers to spend their time efficiently and effectively supporting student learning (Chambré , 2017). "I was able to see their writing in real time. I could make suggestions, immediately point out techniques to try, or have them reflect on areas of improvement" (Chambré , 2017, p. 497). According to Lei and Zhao (2008) "digital experiences have changed not only the ways they communicate, socialize, and entertain, but also fundamentally changed how they approach learning" (p. 98). Students utilized technology in a variety of ways, including problem-solving, collaboration, creativity and recreation (Lei & Zhao, 2008, p. 117).

Summary

As presented in Chapter Two, the implementation of a one-to-one computer program has a variety of components that bring questions about the best way to implement technology usage, both physically and philosophically. The United States Department of Education Office of Educational Technology regularly weighed in on and highlighted programs and policies that could aid in improving availability and usage of computers and internet for students (United States Department of Education, 1996, 2000, 2004, 2010, 2016).

The influence of one-to-one programs on education has been an interest of educators and researchers alike. Themes in Chapter Two included the idea that it was not the existence of technology that improved student performance, experience, and outcome, but rather how it was being utilized as an instructional tool that made the difference (Marcinek, 2015; Lowther et al., 2012; Machado & Chung, 2015; Pautz et al., 2015; Westen & Bain, 2010). Technology has enabled teachers to direct or facilitate personalized instruction through automated programs. Blended learning and self-directed curriculum programs encourage students to take an active responsibility in their roles as students (Tucker et al., 2017).

Activities and experiences that were not previously a possibility become a reality through one-to-one technology. "With the emergence of laptop initiatives on the rise, it is promising that research has found that laptops support significant opportunities for improvement within the educational setting" (Holcomb, 2009, p. 54). Puentedura's SAMR framework (2009) defined levels of technology integration and mapped out how to reach more profound experiences through design of lessons using advancements in instructional technology. Engaging students in rigorous learning activities that require students to think at a higher depth of knowledge level increases problem-solving capabilities and enhances their 21st century skillset (Neebe & Roberts, 2015) (Hess et al., 2009).

Chapter Three includes an introduction to the classroom observation-recording tool, a description of the data sample entailing specific content and time of day observed as well as information about the participants in the teacher perception survey. The researcher also provides descriptions of the specific statistical test in order to analysis data surrounding each hypothesis.

Chapter Three: Research Method and Design

Introduction

The district of study was chosen for research in the midst of planning to acquire Chromebooks for students. The high school was chosen to receive one-to-one computers for the first year, and the middle school was chosen to implement the one-to-one program the following year. Located approximately 50 miles away from a large city, many nearby districts had already implemented similar programs. The district of study had also recently accomplished marked improvement in their standardized tests scores and did not want to lose any rigor or engagement that aided in student success. Development of a systematic approach to measure rigor and engagement was a priority to ensure the quality of the educational experience.

The researcher conducted the study to seek a difference between measures of student levels of rigor and engagement, when comparing use of educational technology in conjunction with a one-to-one computer usage program to the more traditional individual access to computer usage. Data derived from pre-and-post, one-to-one computer implementation observations helped to identify differences that may be linked to technology use in classrooms. In addition, teacher perceptions of the effectiveness of the use of one-to-one computers on changing levels of student rigor and engagement were measured.

The research design for the study was quantitative and included primary and secondary data. The district of study collected the secondary data. District administrators used the Rigor Engagement Technology Tool (RETT) recording form to gather and manage observational data. The RETT data allowed the researcher to measure the Depth of Knowledge level during each classroom observation. The observer determined if the lesson was at a DOK level one (recall), or if the lesson reached higher levels, such as a level two (skill/concept), level three (strategic thinking), or level four (extended thinking) (Webb, 2002). The DOK measurement level was taken for classrooms using technology, as well as in classrooms not using technology. To address the hypotheses, the researcher analyzed pre- and post- one-to-one data to determine the validity of the claims made in the hypotheses. The pre one-to-one secondary data was from the 2016-2017 school year, while the post one-to-one secondary data was from the 2017-2018 school year.

In addition, teachers within the district of study had perceptions as to how technology may have affected components of the classrooms and students. The researcher surveyed the perceptions teachers had concerning the academic rigor of the curriculum and coursework and engagement of students in academic activities surrounding technology implementation. The researcher conducted a Likert-type scale survey with participant responses ranging from one to five, represented by Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree, respectively (see Appendix A). Teachers' individual responses remained anonymous and were recorded securely with the support of the Qualtrics platform.

Null Hypotheses

NH1: There is no difference in the Depth of Knowledge observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

NH2: There is no difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

NH3: There is no difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

NH4: There is no difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

NH5: There is no difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

NH6: The average Likert-type scale rating for teacher responses to survey statements are not different from the neutral (3.0). Survey statements are listed in Appendix A.

NH6A: The average Likert-type scale rating for teacher responses to statement one is not different than the neutral (3.0).

NH6B: The average Likert-type scale rating for teacher responses to statement two are not different than the neutral (3.0).

NH6C: The average Likert-type scale rating for teacher responses to statement three are not different than the neutral (3.0).

NH6D: The average Likert-type scale rating for teacher responses to statement four are not different than the neutral (3.0).

NH6E: The average Likert-type scale rating for teacher responses to statement five are not different than the neutral (3.0).

NH6F: The average Likert-type scale rating for teacher responses to statement six are not different than the neutral (3.0).

NH6G: The average Likert-type scale rating for teacher responses to statement seven are not different than the neutral (3.0).

NH6H: The average Likert-type scale rating for teacher responses to statement eight are not different than the neutral (3.0).

NH6I: The average Likert-type scale rating for teacher responses to statement nine are not different than the neutral (3.0).

NH6J: The average Likert-type scale rating for teacher responses to statement 10 are not different than the neutral (3.0).

Data Samples

The 2016-2017 RETT data encompassed 422 classroom observations prior to the district of study's one-to-one computer initiative. Table 3 lists the number of classroom observations per content area.

Table 3

2016-2017: Observational Data Classrooms by Content and Number of Observations

Course Content	Number of Observations
English Language Arts	85
Fine and Practical Arts	45
Mathematics	49
PE/Health	45
Science	70
Social Studies	70
Special Education	19
Vocational Technology	2
Other	37
Total Classrooms Observed	422

Table 3 indicates that not all of courses were equally observed. English Language Arts was coded most often and included traditional English Language Arts classes as well as Reading specific classes. Table 4 illustrates the number of classrooms observed and the hour of day the day in which each of the classrooms was observed. The data displayed in Table 4 shows a majority of the classroom observations occurring during first and second hour.

Table 4

2016-2017: Observational Data Classrooms by Hour in the School Day and Number of Students

Course Content	Number of Classrooms
1st Hour	181
2nd Hour	134
3rd Hour	42
4th Hour	44
5th Hour	0
6th Hour	10
7th Hour	11
Total Classrooms Observed	422

The 2017-2018 RETT data encompassed 382 classroom observations after the implementation of the district of study's one-to-one computer initiative. Table 5 lists the number of classroom observations per content.

Table 5

2017-2018 Observational Data Classrooms by Content and Number of Observations

Course Content	Number of Observations
English Language Arts	98
Fine and Practical Arts	41
Mathematics	94
PE/Health	8
Science	58
Social Studies	65
Special Education	12
Other	6
Total Classrooms Observed	382

While English Language Arts remained consistently high from 2016-2017 to 2017-2018, the ratio for Mathematics in Table 5 is notably higher in the 2017-2018 school year data. Table 6 illustrates the number of classrooms observed and the hour of day the day in which each of the classrooms was observed.

Table 6

2017-2018 Observational Data Classrooms by Hour in the School Day

Course Content	Number of Classrooms
1st Hour	0
2nd Hour	52
3rd Hour	76
4th Hour	139
5th Hour	35
6th Hour	70
7th Hour	10
Total Classrooms Observed	382

The researcher utilized a cluster sample and selected 24 teachers involved with the one-to-one computer initiative (Bluman, 2014). Each of the teachers in the cluster group received a survey with 10 statement prompts (Appendix A). Of the 24 teachers invited to take the survey, 17 teachers responded and completed the survey. The researcher used the *Qualtrics* platform to collect teacher responses.

Data Analysis

For each of the null hypotheses, the researcher performed specific statistical tests using an alpha of 0.05 in order to arrive at a 95% confidence level.

H1: The researcher conducted a two-sample z-test for the difference in proportions to determine if the depth of knowledge observed in lessons prior to one-to-one computer usage was different than post one to computer implementation (Bluman, 2014, p. 519).

H2: The researcher conducted a two-sample *z*-test for the difference in proportions to determine if the Depth of Knowledge in technology-infused lessons prior to one-to-one computer usage was different than post one-to-one computer implementation (Bluman, 2014, p. 519).

H3: The researcher conducted a Chi Square Goodness-of-Fit test in order to determine if there was a difference in the distribution of the SAMR levels between the two years of data (Bluman, 2014, p. 610).

H4: The researcher conducted a Chi Square Goodness-of-Fit test in order to determine if there was a difference in the distribution of the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage (Bluman, 2014, p. 610).

H5: The researcher conducted a *t*-test for the difference in two means to see if there was a difference in the number of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage (Bluman, 2014, p. 507).

H6: The researcher compiled and analyzed results using a Likert-type scale with options ranging from one to five, with three being the neutral classification. The researcher conducted a one-sample *t*-test for difference in means to determine if teacher responses were higher or lower than neutral (3.0) for each of the 10 statements asked in the survey (Bluman, 2014, p. 442). The statements appear in Appendix A.

Reliability, Validity, and Measurement

The researcher conducted statistical tests for each of the hypotheses to determine whether to reject the null (Bluman, 2014, p. 414). School district administrators, who served as the research observers, met at the beginning of each school year to conduct trial observation walk-throughs to discuss and normalize the observations using the RETT tool. The process helped the district create a stronger observational data set.

The population observation number for the 2016-2017 school year was 422 throughout the year. The population observation number for the 2017-2018 school year was 382. Both numbers were large enough to ensure a strong statistical analysis (Bluman, 2014). In terms of the teacher population of 24, approximately 71% of those in the population responded and completed the survey. These numbers were large enough for the researcher to conduct a series of one-sample *t*-tests for difference in means to determine if teacher responses to statement one were higher than neutral (3.0).

Study Limitations Revisited

The researcher identified the several limitations in this study. The results of this study were limited to the survey responses of teacher participants included in the one-to-one implementation. In terms of grade level and age of the observed population, classrooms observed were limited to sixth, seventh, and eighth grade with students ranging in ages from 11 to 15. The researcher used participants from a single school located in a semi-rural community to gather data. This was the only middle school in the district of study.

Classrooms were entered without prior notification to the teacher that an observation was to occur. The data were from brief classroom observations and did not take into account information in lesson plans. A disproportionate amount of observations were in the mornings, per data collectors' schedule. Equality in time of day and content of classroom observation were not equally distributed. For example, more math classes were observed than choir classes due to more sections available during the timeframe of observations.

In terms of the teacher perception of student rigor and engagement while utilizing one-to-one technology, the researcher did not assign baseline surveys for the participants to state pre-perception data on Depth of Knowledge, SAMR, and other factors prior to the implementation of a one-to-one computer usage program.

Summary

Chapter Three included an introduction to the setting of the study as well as the classroom observation-recording tool known as the RETT form. The researcher provided a description of the data sample entailing specific content and time of day observed, as well as information about the participants in the teacher perception survey. The researcher also provided descriptions of the specific statistical test to analysis each hypothesis, which included a z-test for difference in means, a t-test for difference in means, and a Chi Square Goodness-of-Fit Test for difference in distributions. In Chapter Four, the researcher presents the analysis of specific results through the utilization of the statistical tests.

Chapter Four: Results

Introduction

The purpose of this study was to analyze the effects on characteristics of rigor and engagement by comparing measures taken prior to one-to-one computer implementation and post one-to-one computer implementation. In addition, a teacher perception survey was a crucial component in this study in order to determine that student and teacher resources, professional development, and pedagogical models were in place. Hattie (2012) indicated in his research that teachers make the difference and have an enormous impact on student academic achievement, as well as the student learning experience. Teacher direct-survey participation allowed human context to be included with the standardized classroom observations.

The information and results described in Chapter Four can aid as a component for decision-making for school districts as they determine the best course of action for students and staff concerning educational technology and one-to-one computer programming.

Null Hypotheses

Null Hypothesis 1: There is no difference in the Depth of Knowledge observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Null Hypothesis 2: There is no difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Null Hypothesis 3: There is no difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Null Hypothesis 4: There is no difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Null Hypothesis 5: There is no difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Null Hypothesis 6: The average Likert-type scale rating for teacher responses to survey statements are not different than the neutral (3.0).

Null Hypothesis 6A: The average Likert-type scale rating for teacher responses to statement one is not different than the neutral (3.0).

Null Hypothesis 6B: The average Likert-type scale rating for teacher responses to statement two are not different than the neutral (3.0).

Null Hypothesis 6C: The average Likert-type scale rating for teacher responses to statement three are not different than the neutral (3.0).

Null Hypothesis 6D: The average Likert-type scale rating for teacher responses to statement four are not different than the neutral (3.0).

Null Hypothesis 6E: The average Likert-type scale rating for teacher responses to statement five are not different than the neutral (3.0).

Null Hypothesis 6F: The average Likert-type scale rating for teacher responses to statement six are not different than the neutral (3.0).

Null Hypothesis 6G: The average Likert-type scale rating for teacher responses to statement seven are not different than the neutral (3.0).

Null Hypothesis 6H: The average Likert-type scale rating for teacher responses to statement eight are not different than the neutral (3.0).

Null Hypothesis 6I: The average Likert-type scale rating for teacher responses to statement nine are not different than the neutral.

Null Hypothesis 6J: The average Likert-type scale rating for teacher responses to statement 10 are not different than the neutral (3.0).

Statistical Results

Null Hypothesis 1: There is no difference in the Depth of Knowledge observed in lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Table 7

Classroom Depth of Knowledge Level for "Most Students"

Depth of Knowledge	2016-2017 School Year	2017-2018 School Year
DOK Level 1	156	140
DOK Level 2-4	266	242
Total	422	382

Table 7 shows the DOK Level one observation and DOK two through four observations recorded for during each classroom visiting the 2016-2017 and 2017-2018 school years. The researcher conducted a two-sample *z*-test for difference in proportions to determine if the DOK observed in lessons prior to one-to-one computer usage was different from the post one-to-one computer implementation. The analysis revealed that the number of lessons observed with students reaching a DOK level of two to four prior one-to-one implementation (n = 422 , 63.0%) was not significantly different from the number of lessons with students reaching a DOK level of two to four post one-to-one implementation (n = 382, 63.4%); $z = -0.117$, $p = 0.906$. Figure 3 shows the visualization by percentage of classrooms observed DOK level one and DOK two-four for the 2016-2017 and 2017-2018 school years.

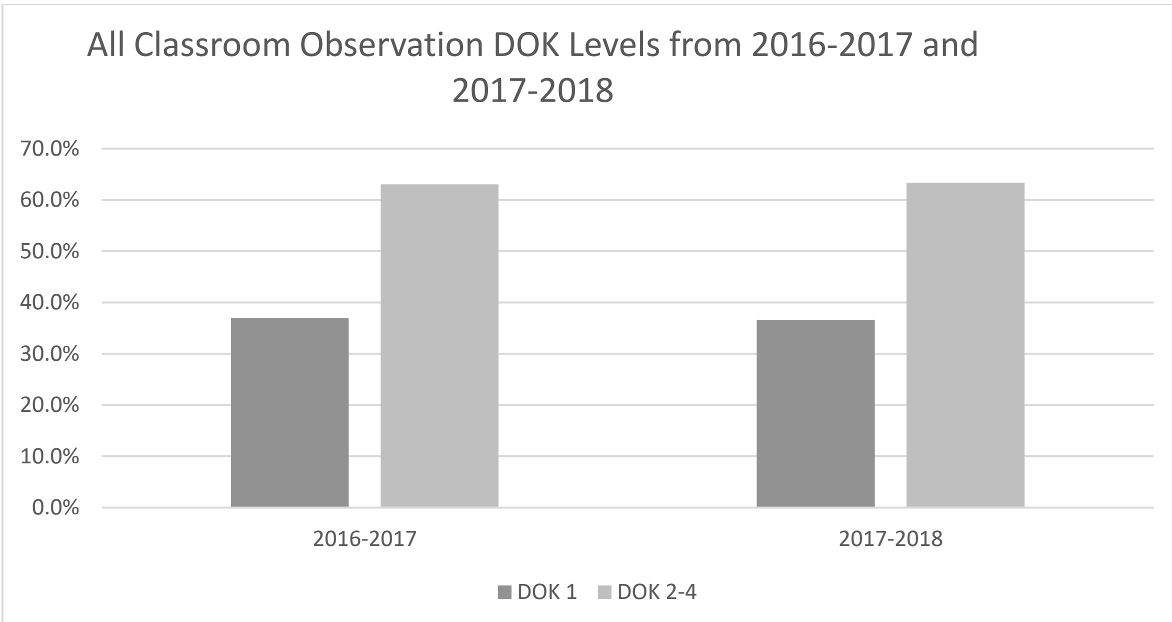

Figure 3. *Classroom observation DOK levels.*

The researcher failed to reject the null hypothesis and concluded that no difference was observed in the lessons prior to the one-to-one computer implementation and after the one-to-one computer implementation.

Null Hypothesis 2: There is no difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Table 8

Classroom Depth of Knowledge Level for "Most Students" during Engagement with Technology

Depth of Knowledge	2016-2017 School Year	2017-2018 School Year
DOK Level 1	42	26
DOK Level 2-4	89	117
Total	131	143

Table 8 shows the DOK Level one observations and DOK two through four observations recorded for each classroom visit during the 2016-2017 and 2017-2018 school years, specifically in classrooms with lessons infused with technology. The researcher conducted a two-sample *z*-test for difference in proportions to determine if the DOK in technology-infused lessons prior to one-to-one computer usage was different than post one-to-one computer implementation. The analysis revealed that the number of lessons infused with technology with students reaching a DOK level of two to four prior to one-to-one implementation (n = 131 , 67.9%) was significantly different from the number of lessons with students reaching a DOK level of two to four post one-to-one implementation (n = 143, 81.8%); $z = -2.661$, $p = 0.007$. Figure 4 shows the visualization by percentage of classrooms observed DOK level one and DOK two through four for the 2016-2017 and 2017-2018 school years, specifically in classrooms with lessons infused with technology.

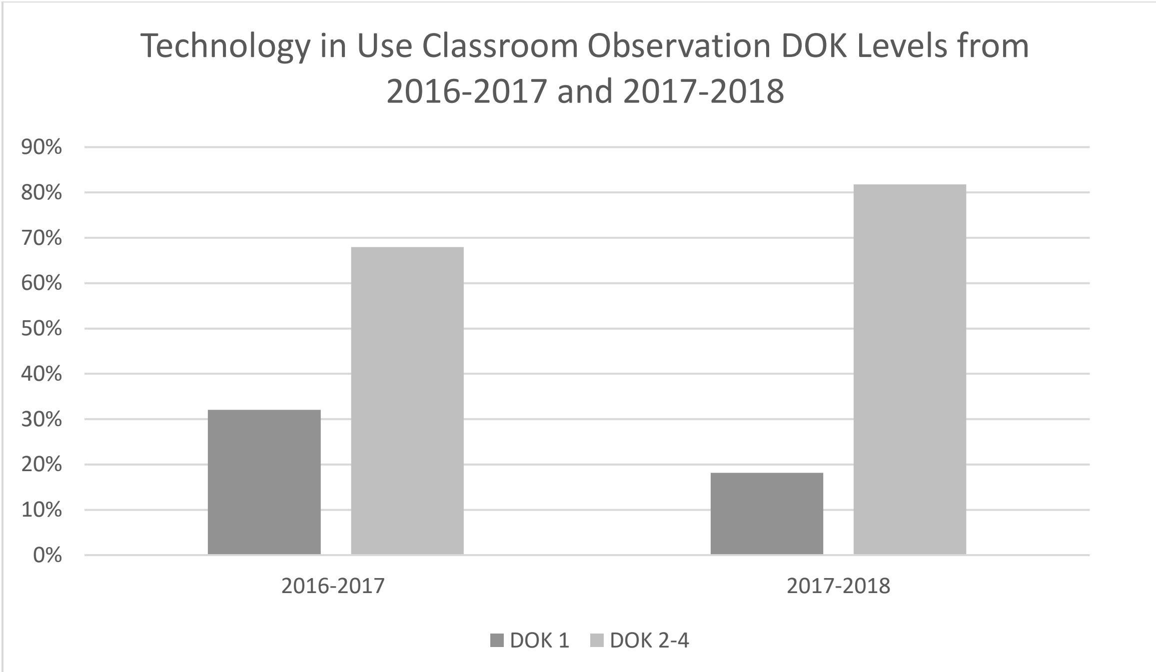

Figure 4. Classroom Observation DOK Levels

The researcher rejected the null hypothesis and concluded that difference was observed in the DOK level in technology-infused lessons prior to the one-to-one computer implementation and after the one-to-one computer implementation.

Null Hypothesis 3: There is no difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

The researcher conducted a Chi Square Goodness-of-Fit test in order to determine if there was a difference in the distribution of the SAMR levels from between the two years of data, representing before and after one-to-one computer usage by students. SAMR levels represent the characteristics of Substitution, Augmentation, Modification, and Redefinition. Table 9 compares the distributions of the SAMR levels from the 2016-2017 and 2017-2018 academic years.

Table 9

Distribution of the SAMR Levels

Year	Substitution	Augmentation	Modification	Redefinition	Total
2016-2017	58	62	7	2	129
2017-2018	12	67	54	9	142

The analysis revealed that a significant difference existed between the distribution; $\chi2(3, n = 142) = 341.0$, $p < 0.001$. Figure 5 represents the distribution of SAMR levels from the 2016-2107 and 2017-2018 school years.

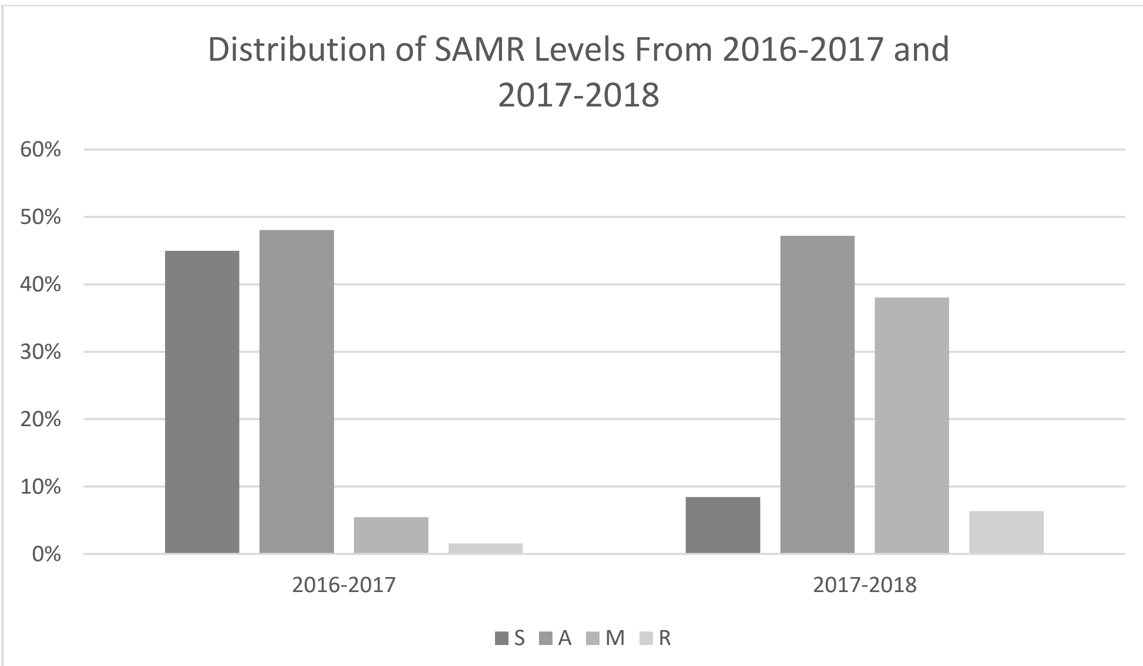

Figure 5. Distribution of SAMR Levels

The researcher rejected the null hypothesis and concluded that the distribution of levels of the characteristics measured by the SAMR model was significantly different between the two years of data, representing the pre- and post-usage of one-to-one computer programming.

Null Hypothesis 4: There is no difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Table 10

Student Technology Engagement Observations

Activity Types	2016-2017 School Year	2017-2018 School Year
Assessments	13	15
Communication and Collaboration	22	12
Creativity and Innovation	20	8
Critical Thinking and Problem Solving	6	29
Digital Citizenship	1	0
Research and Informational Fluency	31	46
Technology Operations and Concepts	10	12
Word Processing or Math Computations	19	20

Table 10 depicts the activity types that utilized technology during observations from the 2016-2017 and 2017-2018 school years. The researcher conducted a Chi Square Goodness of Fit test in order to determine if there was a difference in the distribution of the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage. The analysis revealed that a significant difference existed in the distribution; $\chi 2(7, n = 14) = 87.00$, $p < 0.001$. Table 11 details the overall percentage of the activity types that utilized technology during observations from the 2016-2017 and 2017-2018 school years.

Table 2

Student Technology Engagement Observations by Percentage Changed

Activity Types	2016-2017 School Year	2017-2018 School Year
Assessments	10.66%	10.56%
Communication and Collaboration	18.03%	8.45%
Creativity and Innovation	16.39%	5.63%
Critical Thinking and Problem Solving	4.92%	20.42%
Digital Citizenship	0.82%	0 .00%
Research and Informational Fluency	25.41%	32.39%
Technology Operations and Concepts	8.20%	8.45%
Word Processing or Math Computations	15.57%	14.08%

The researcher rejected the null hypothesis and concluded that a difference in the distribution of the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage was significant between the two years of data, representing the pre- and post-usage of one-to-one computer programming. Figure 6 is a visual depiction of the learning activity types utilizing a bar graph comparison for the distribution of each activity type for the 2016-2017 and the 2017-2018 school years.

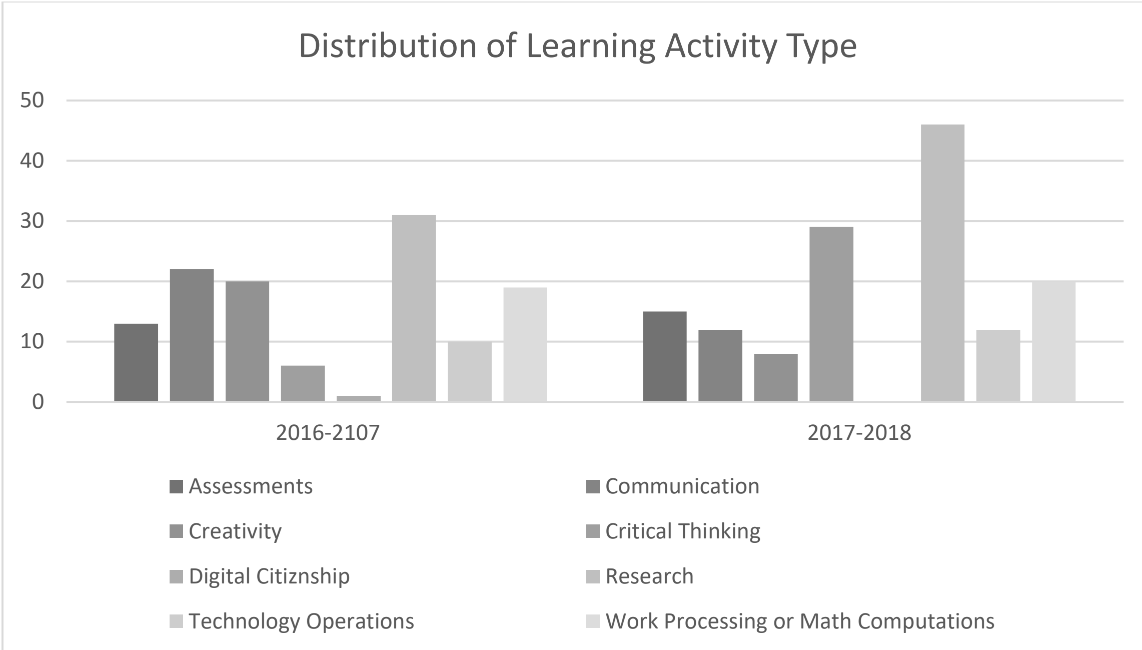

Figure 6. Student Technology Engagement Observations by Percentage Changed

Null Hypothesis 5: There is no difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

The researcher conducted a *t*-test for difference in two independent means to see if there was a difference in the number of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage. A preliminary test of variances revealed that the variances were not equal. The analysis revealed that the mean number of students engaged with technology prior to one-to-one computer usage (M = 3.75, SD = 7.75) was significantly different than the mean of the students engaged with technology after the implementation of one-to-one computer usage (M = 6.06, SD = 9.37); $t(381) = -3.78$, $p = 0.0002$. Table 12 shows the total number of students observed engaged in technology and the average number of students per classroom observed using technology from the 2016-2017 and 2017-2018 school years.

Table 3

Students Engaged in Technology Pre and Post One-to-One Computer Implementation

Depth of Knowledge	2016-2017 School Year	2017-2018 School Year
Students Engaged in Technology	1583	2316
Total Classrooms Observed	422	382
Average Per Classroom Observed	3.75	6.06

The researcher rejected the null hypothesis and concluded that the number of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage was significantly different.

Null Hypothesis 6: Teacher responses to survey statements are not different than the neutral (3.0).

The researcher conducted a one-sample t-test for difference in means to determine if the average teacher responses to all of the statements in the survey were different than neutral (3.0). The analysis revealed that responses to all statements collectively (M = 3.65, SD = 1.079) were different and significantly higher than the neutral response of (3.0); $t(16) = 2.48$, $p = 0.0245$. The researcher rejected the null hypothesis and concluded that average Likert-type scale for teacher perceptions as collected on survey responses were significantly different and higher than the neutral response. Table 13 represents the percent of responses overall that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey out of the number of total responses to item prompts.

Table 4

Teacher responses to survey statements collectively

Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total
5	(2.94%)	26	(15.29%)	31	(18.23%)	70	(41.17%)	38	(22.35%)	170

Figure 7 visually represents the percentage of responses overall, that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey out of the number of total responses to item prompts.

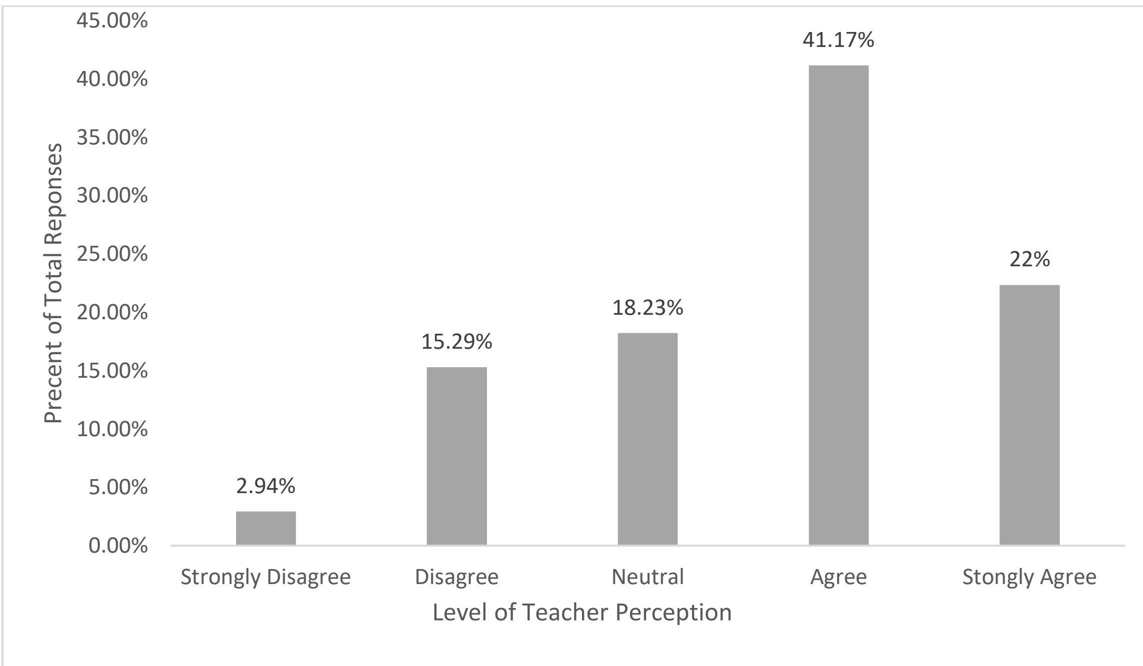

Figure 7. Level of Teacher Perception

Null Hypothesis 6A: The average Likert-type scale rating for **t**eacher responses to statement one is not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test for difference in means to determine if teacher responses to statement one was different than neutral (3.0). Statement one prompted, “Students on technological devices are typically engaged during a lesson.” The analysis revealed that responses to statement one (M = 3.65, SD = 0.86) were significantly different and higher than the neutral response of (3.0).; $t(16) = 3.10$, $p = .0035$. The researcher rejected the null hypothesis and concluded that the average Likert-type scale for teacher perceptions for statement one, “Students on technological devices are typically engaged during a lesson,” were significantly different and higher than the neutral response. Table 14 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students on technological devices are typically engaged during a lesson.”

Table 5

Students on technological devices are typically engaged during a lesson.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1 (5.88%)	1 (5.88%)	1 (5.88%)	14 (82.35%)	0 (0%)	17

Figure 8 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students on technological devices are typically engaged during a lesson”.

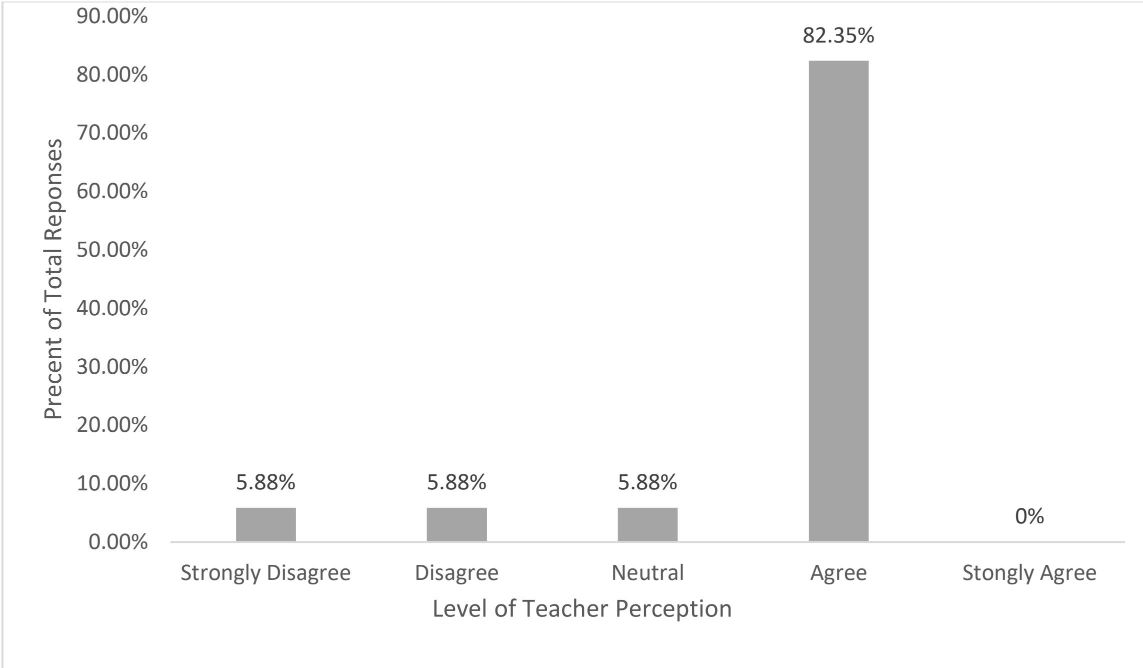

Figure 8. Level of Teacher Perception 6A

Null Hypothesis 6B: The average Likert-type scale rating for teacher responses to statement two are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test for difference in means to determine if the average Likert-type scale rating for teacher response to statement two were different than neutral (3.0). Statement two prompted, “Students can typically reach high Depth of Knowledge levels during lessons while using technology devices.” The analysis revealed that responses to statement two (M = 4, SD = 0.82) were significantly different and higher than the neutral response of 3; $t(16) = 5.05$, $p = 0.0001$. The researcher rejected the null hypothesis and concluded that teacher perceptions for statement two, “Students can typically reach high Depth of Knowledge levels during lessons while using technology devices,” were significantly different and higher than the neutral response.

Figure 9 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students can typically reach high Depth of Knowledge levels during lessons while using technology devices”.

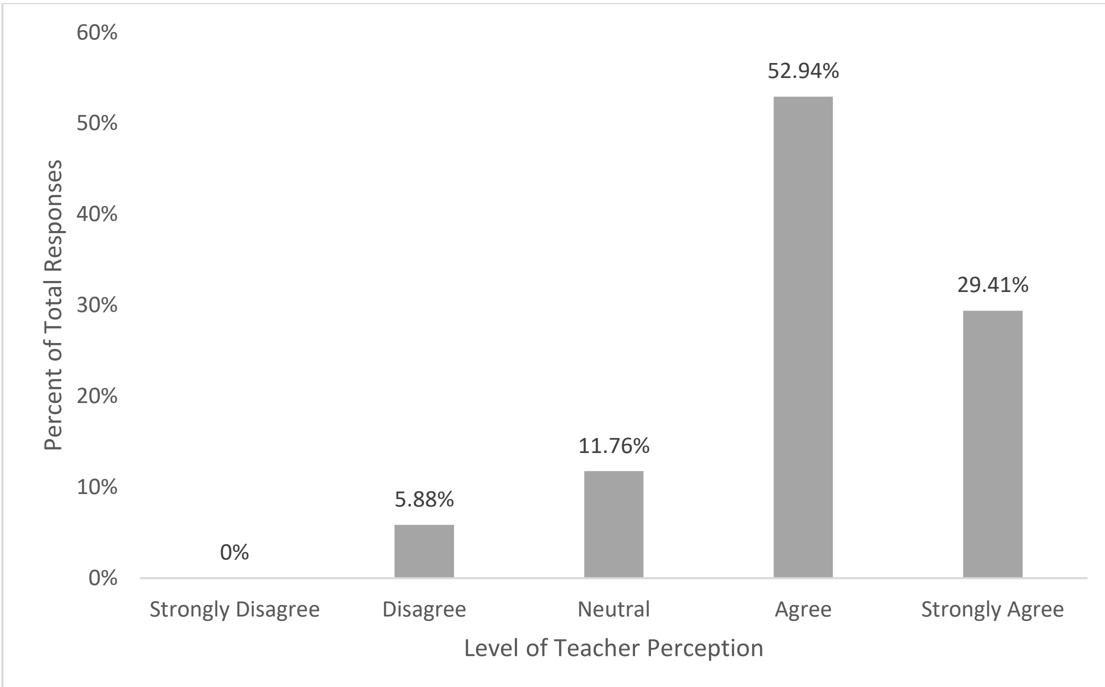

Figure 2. Level of Teacher Perception 6B

Table 15 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students can typically reach high Depth of Knowledge levels during lessons while using technology devices”.

Table 6

Students can typically reach high Depth of Knowledge levels during lessons while using technology devices.

Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total
0	(0%)	1	(5.88%)	2	(11.76%)	9	(52.94%)	5	(29.41%)	17

Null Hypothesis 6C: The average Likert-type scale rating for teacher responses to statement three are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test for difference in means to determine if the average Likert-type scale rating for teacher responses to statement three were different than neutral (3.0). Statement three, "Teachers can formatively assess students during lessons while students are using technological devices." The analysis revealed that responses to statement three (M = 4.35, SD = 0.49) were significantly different and higher than the neutral response of 3; $t(16) = 11.3$, $p < .001$. The researcher rejected the null hypothesis and concluded that the average Likert-type scale rating for teacher perceptions for statement three, "Teachers can formatively assess students during lessons while students are using technological devices," were significantly different and higher than the neutral response.

Table 16 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, "Teachers can formatively assess students during lessons while students are using technological devices".

Table 7

Teachers can formatively assess students during lessons while students are using technological devices.

Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total
0	(0%)	0	(0%)	0	(0%)	11	(64.71%)	6	(35.29%)	17

Figure 10 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Teachers can formatively assess students during lessons while students are using technological devices”.

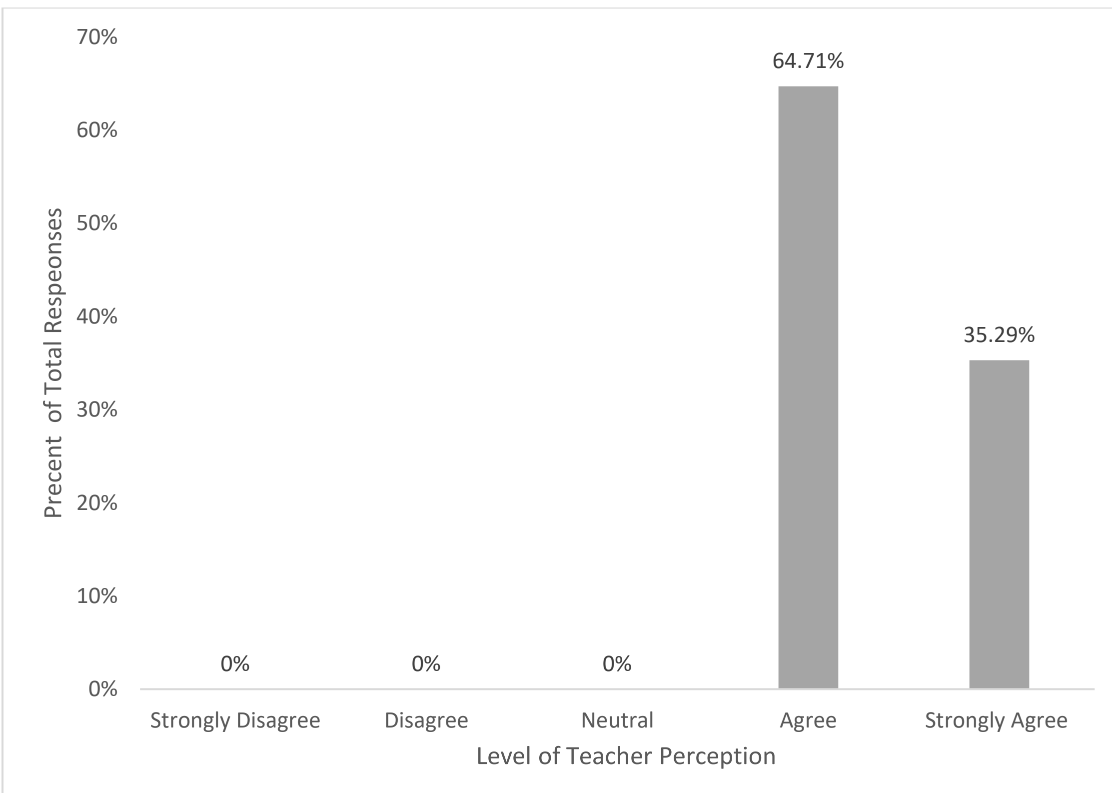

Figure 3. Level of Teacher Perception 6C

Null Hypothesis 6D: The average Likert-type scale rating for teacher responses to statement four are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test to determine if the average Likert-type scale rating for teacher responses to statement four were different than neutral (3.0). Statement four prompted, “Students are more distracted during a lesson without a technology device than a lesson with a technology device.” The analysis revealed that responses to statement four (M = 2.82, SD = 0.95) were not significantly nor significantly higher than the neutral response of 3; $t(16) = -0.78$, $p = 0.78$. The researcher failed to reject the null hypothesis and concluded that the average Likert-type scale rating for teacher perceptions for statement four, “Students are more distracted during a lesson without a technology device than a lesson with a technology device,” were not significantly different nor significantly lower than the neutral response. Table 17 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students are more distracted during a lesson without a technology device than a lesson with a technology device”.

Table 8

Students are more distracted during a lesson without a technology device than a lesson with a technology device.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1 (5.88%)	5 (29.41%)	8 (47.06%)	2 (11.76%)	1 (5.88%)	17

Figure 11 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, "Students are more distracted during a lesson without a technology device than a lesson with a technology device".

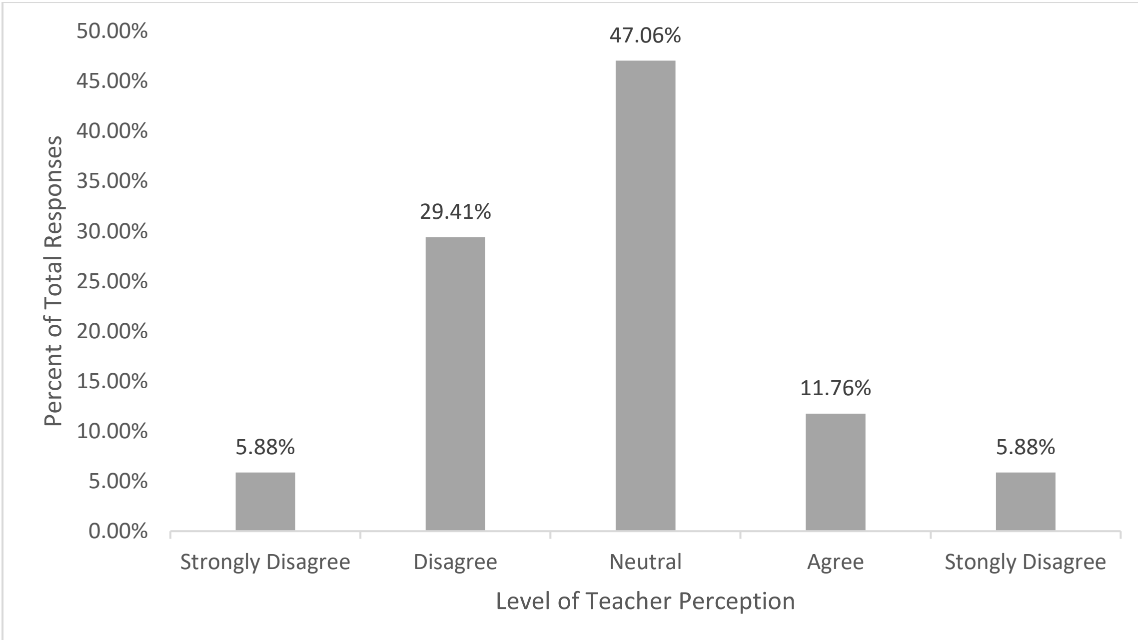

Figure 11. Level of Teacher Perception 6D

Null Hypothesis 6E: The average Likert-type scale rating for teacher responses to statement five are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test to determine if the average Likert-type scale rating for teacher responses to statement five were different than neutral (3.0). Statement five, "Students take most assessments on technological devices." The analysis revealed that responses to statement five (M = 3.71, SD = 1.26) were significantly different and higher than the neutral response of 3; $t(16) = 2.32$, $p = 0.017$. The researcher rejected the null hypothesis and concluded that the average Likert-type scale rating for teacher perceptions for statement five, "Students take most assessments on technological devices," were significantly different and higher than the neutral response.

Table 18 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students take most assessments on technological devices”.

Table 9

Students take most assessments on technological devices.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
0 (0%)	5 (29.41%)	1 (5.88%)	5 (29.41%)	6 (35.29%)	17

Figure 12 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Students take most assessments on technological devices”.

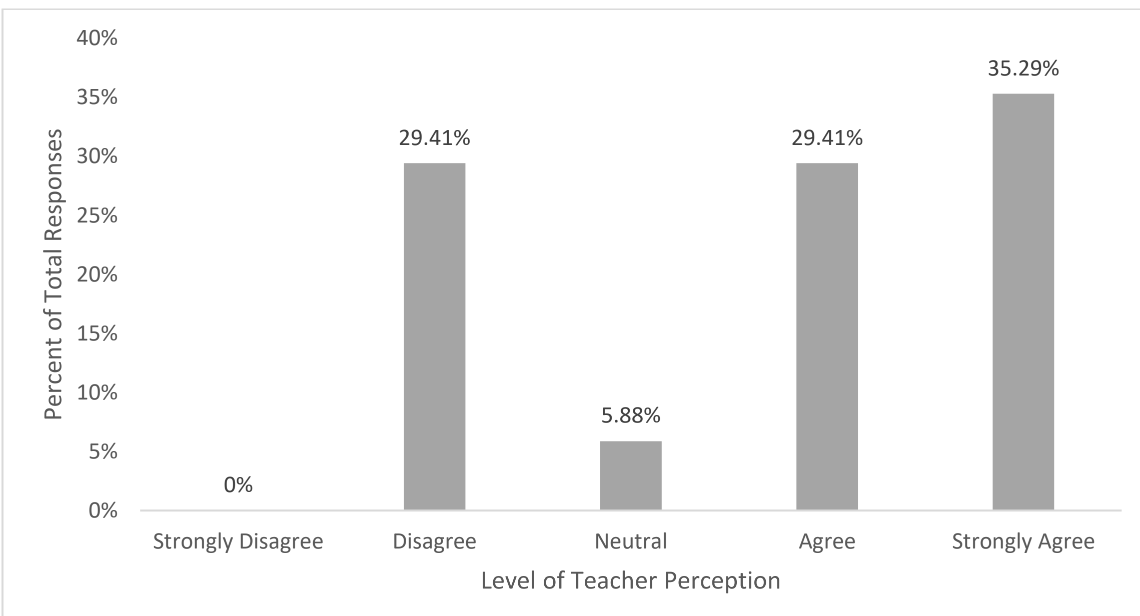

Figure 4. Level of Teacher Perception 6E

Null Hypothesis 6F: The average Likert-type scale rating for teacher responses to statement six are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test for difference in means to determine if the average Likert-type scale rating for teacher responses to statement six were different than neutral (3.0). Statement six prompted, “Technology is needed to effectively teach my students.” The analysis revealed that responses to statement six (M = 2.53, SD = 0.72) were significantly different and lower than the neutral response of 3; $t(16) = -2.69$, $p = 0.016$. The researcher rejected the null hypothesis and concluded that the average Likert-scale teacher perceptions for statement six, “Technology is needed to effectively teach my students” were significantly different and lower than the neutral response.

Table 19 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Technology is needed to effectively teach my students”.

Table 10

Technology is needed to effectively teach my students.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1 (5.88%)	7 (41.18%)	8 (47.06%)	1 (5.88%)	0 (0%)	17

Figure 13 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Technology is needed to effectively teach my students”.

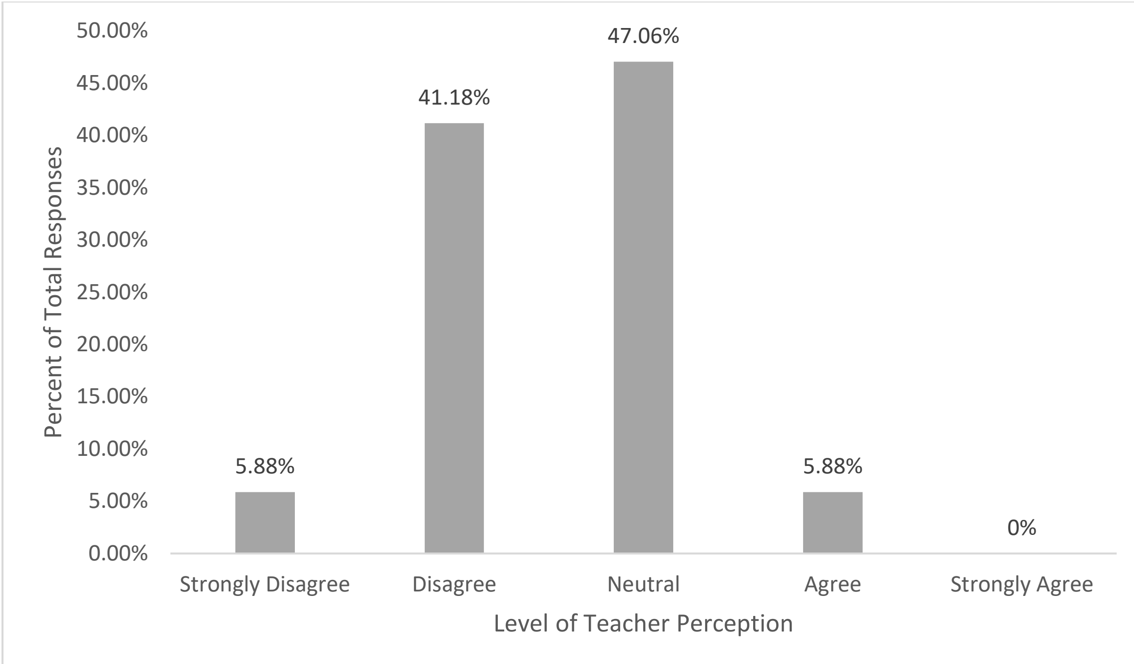

Figure 5. Level of Teacher Perception 6F

Null Hypothesis 6G: The average Likert-type scale rating for teacher responses to statement seven are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test to determine if the average Likert-type scale rating for teacher responses to statement seven were different than neutral (3.0). Statement seven prompted, "Teachers allow technological devices to be used by students the majority of the time in the classroom." The analysis revealed that responses to statement seven (M = 3.76, SD = 1.09) were significantly different and higher than the neutral response of 3; $t(16) = 2.88$, $p = 0.006$. The researcher rejected the null hypothesis and concluded that the average Likert-type scale rating for teacher perceptions for statement seven, "Teachers allow technological devices to be used by students the majority of the time in the classroom," were significantly different and higher than the neutral response.

Figure 14 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Technology is needed to effectively teach my students”.

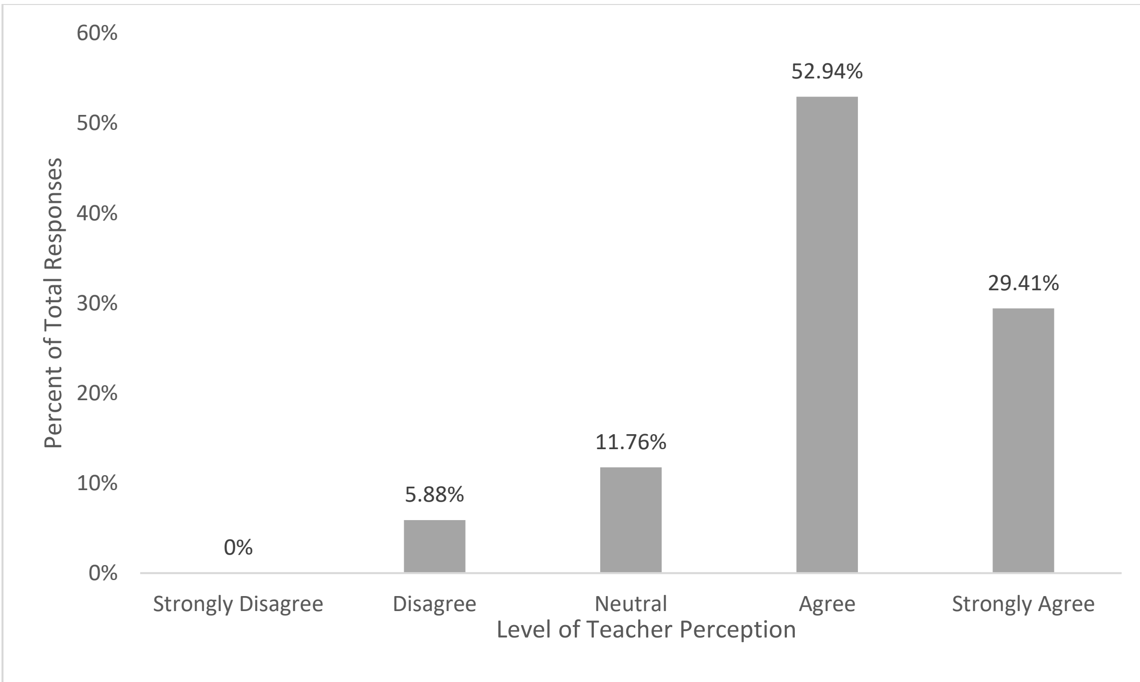

Figure 6. Level of Teacher Perception 6G

Table 20 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “Technology is needed to effectively teach my students”.

Table 11

Teachers allow technological devices to be used by students the majority of the time in the classroom.

Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total
0	(0%)	1	(5.88%)	2	(11.76%)	9	(52.94%)	5	(29.41%)	17

Null Hypothesis 6H: The average Likert-type scale rating for **t**eacher responses to statement eight are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test to determine if the average Likert-type scale rating for teacher responses to statement eight were different than neutral (3.0). Statement eight prompted, “I see clear benefits for students having individual technological devices in school.” The analysis revealed that responses to statement eight (M = 4.24, SD = 0.66) were significantly different and higher than the neutral response of 3; $t(16) = 7.75$, p =approaching 0. The researcher rejected the null hypothesis and concluded that the average Likert-type scale rating for teacher perceptions for statement eight, “I see clear benefits for students having individual technological devices in school,” were significantly different and higher than the neutral response.

Table 21 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I see clear benefits for students having individual technological devices in school”.

Table 12

I see clear benefits for students having individual technological devices in school.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
0 (0%)	0 (0%)	2 (11.76%)	9 (52.94%)	6 (35.29%)	17

Figure 15 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I see clear benefits for students having individual technological devices in school.”

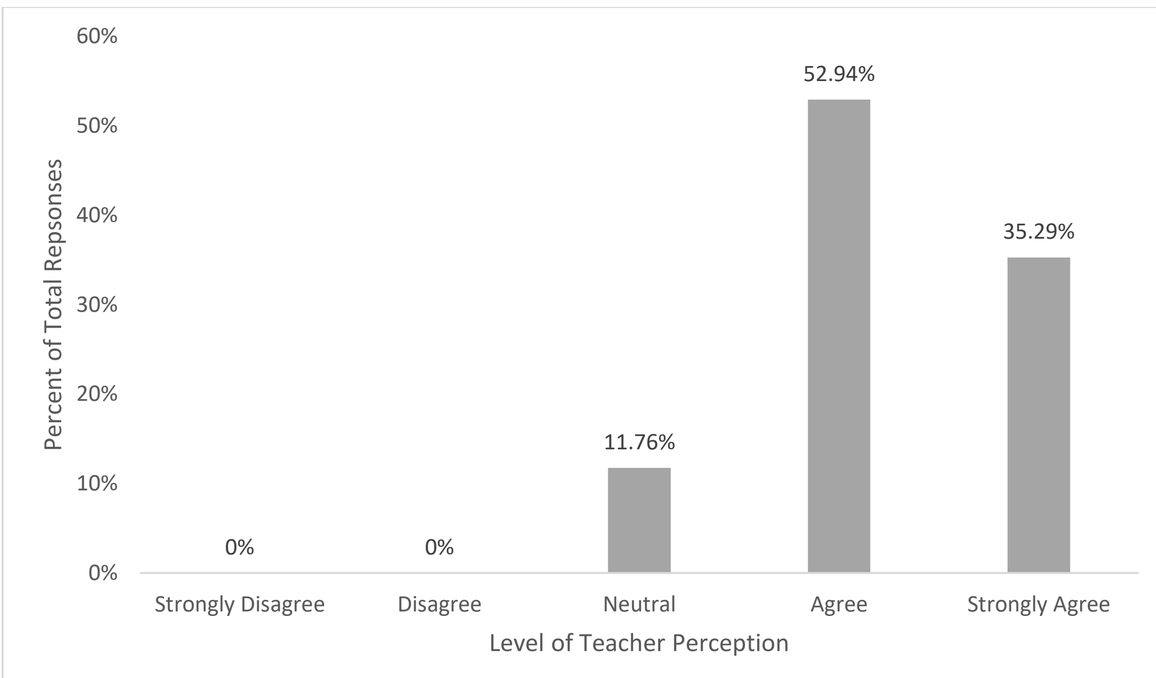

Figure 7. Level of Teacher Perception 6H

Null Hypothesis 6I: The average Likert-type scale rating for teacher responses to statement nine are not different than the neutral.

The researcher conducted a one-sample *t*-test to determine if average Likert-type scale rating for teacher responses to statement nine were different than neutral (3.0). Statement nine prompted, “I understand the SAMR model and how it relates to students and technology.” The analysis revealed that responses to statement nine (M = 3.53, SD = 1.28) were not significantly different nor significantly higher than the neutral response of 3; $t(16) = 1.71$, $p = 0.054$. The researcher failed to reject the null hypothesis and concluded that average Likert-type scale rating for teacher perceptions for statement nine, “I understand the SAMR model and how it relates to students and technology,” were not significantly different nor significantly higher than the neutral response.

Table 22 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I understand the SAMR model and how it relates to students and technology”.

Table 13

I understand the SAMR model and how it relates to students and technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1 (5.88%)	3 (17.65%)	4 (23.53%)	4 (23.53%)	5 (29.41%)	17

Figure 16 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I understand the SAMR model and how it relates to students and technology”.

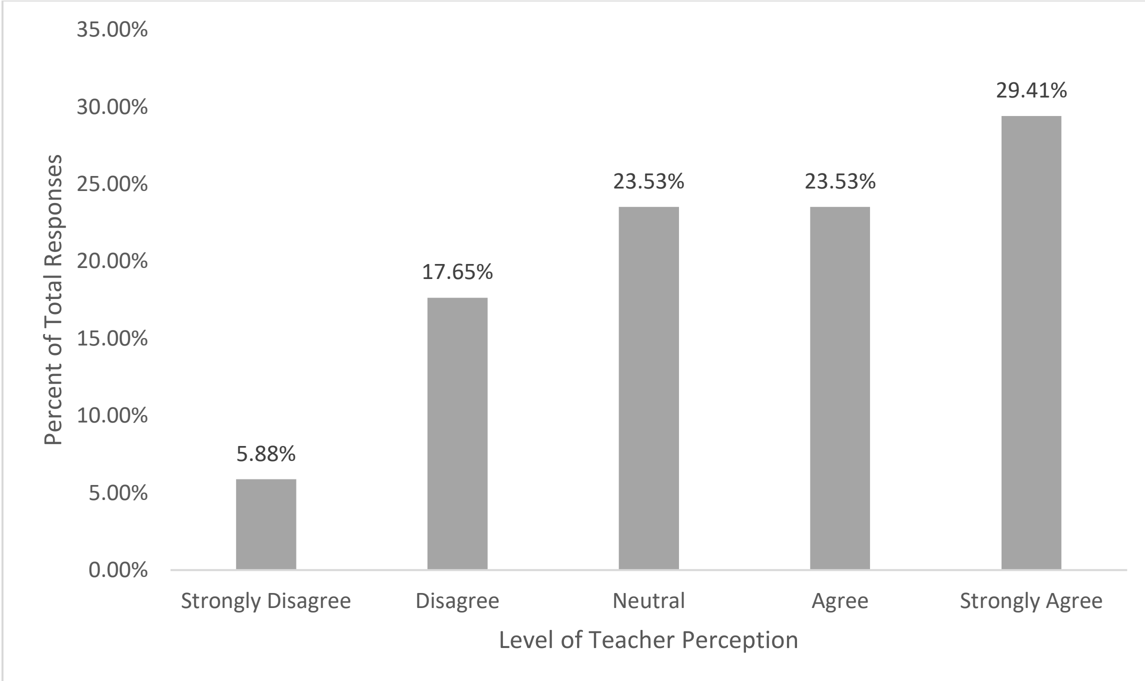

Figure 8. Level of Teacher Perception 6I

Null Hypothesis 6J: The average Likert-type scale rating for teacher responses to statement ten are not different than the neutral (3.0).

The researcher conducted a one-sample *t*-test to determine if average Likert-type scale rating for teacher responses to statement 10 were different than neutral (3.0). Statement 10 prompted, "I have received adequate training on designing lessons that incorporate students using technological devices." The analysis revealed that average Likert-type scale responses to statement 10 (M = 3.82, SD = 1.07) were significantly different and higher than the neutral response of 3; $t(16) = 3.16$, $p = 0.003$. The researcher rejected the null hypothesis and concluded that average Likert-type scale rating for teacher perceptions for statement 10, "I have received adequate training on designing lessons that incorporate students using technological devices," were significantly different higher than the neutral response.

Table 23 represents the percent of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I have received adequate training on designing lessons that incorporate students using technological devices”.

Table 14

I have received adequate training on designing lessons that incorporate students using technological devices.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
1 (5.88%)	1 (5.88%)	2 (11.76%)	9 (52.94%)	4 (23.53%)	17

Figure 17 visually represents the percentage of responses that indicated the teacher strongly disagreed, disagreed, was neutral, agreed, or strongly agreed on the teacher perception survey on the item, “I have received adequate training on designing lessons that incorporate students using technological devices”.

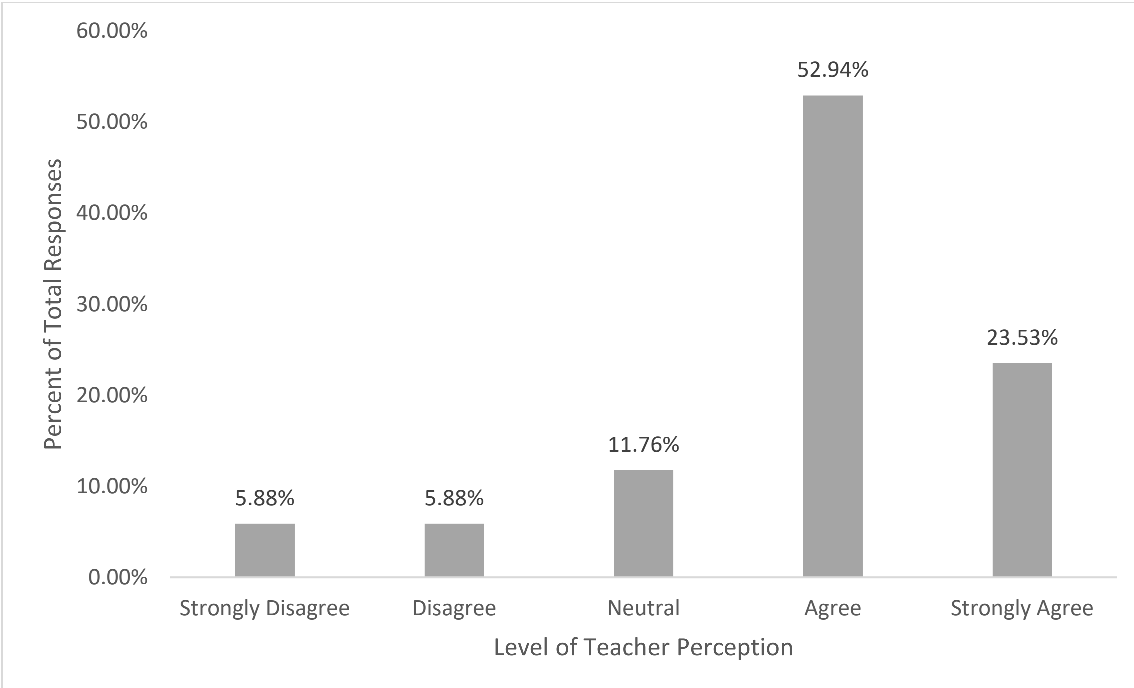

Figure 17. Level of Teacher Perception; 6J

Summary

In Chapter Four, the results from the RETT observation forms were collected and were analyzed. The data compared the two different school years, prior one-to-one computers (2016-2017) and after one-to-one computers (2017-2018). Statistical analysis of each hypothesis rendered the results found in this chapter. Additionally, the researcher conducted several one-sample *t*-tests for difference in means in order to determine whether to reject the null hypotheses regarding the average Likert-type scale rating for teacher perceptions on survey questions. Chapter Five provides a further look at the data analysis and includes implications, discussion, and recommendations based on the results.

Chapter Five: Discussion

Literature Review Findings

Technology inundated students, educators, and school systems with resources in recent years. Technology resources and devices became more affordable and more available than ever before (Hilton, 2015). Implementation of one-to-one programs left the question on the table; Did the cart come before the horse? Extensive research of one-to-one programs described in the literature review unveiled that there was more to student engagement and rigor in the classroom then simply having a device for each student. The U.S. Department of Education's Office of Educational Technology has provided stakeholders with guidance concerning use of technology in the classroom since 1996 (U.S, Department of Education, 2017, p. 4). The reports provided not only financial pathways for ubiquitous access to technological resources, but also strategies, methods, and roadmaps for current best practices (U.S. Department of Education, 2017).

The transformative nature of technology platforms, such as Google Suite, provide comprehensive access to processing resources, as well as collaboration capabilities (Smith & Mader, 2017). Research indicated that most one-to-one programs produced results that did not disparage the student learning experience (Machado & Chung, 2015). Embedding technology into the lessons is what ultimately has the greatest influence on engagement. (Westen & Bain, 2010).

Instructional strategies and interventions with technology programs can support student growth and development (House, 2012). Blended learning supports the idea that teachers are able to facilitate students' classroom experiences without being direct instructors or the gatekeepers of knowledge (Tucker et al., 2017).

The teacher professional is crucial in order to support a one-to-one program introduction (Livingston, 2009). Through understanding, teachers can use the technology resources in a way that will enhance student achievement (Teo et al., 2008). Puentedura's (2009) SAMR model contains elements that support teachers with technology integration through looking at whether the technology is used as a substitution, augmentation, modification, or redefinition of the previous state of the educational experience. By providing rigorous assignments, incorporating DOK, and building in engagement activities, technology devices can bridge student learning from the 20th to 21st century skills acquisition.

Hypotheses

The researcher investigated pre-to-post, one-to-one computer usage, in order to determine if there were significant differences among the variables compared in the hypotheses.

H1: There is a difference in the Depth of Knowledge observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H2: There is a difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H3: There is a difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H4: There is a difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H5: There is a difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

H6: The average Likert-type scale rating for teacher responses to survey statements are different than the neutral (3.0).

Summary of Findings

H1: There is a difference in the Depth of Knowledge observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

As described in Chapter Four, there was not a statistically significant difference found in the DOK level observed prior to and after one-to-one implementation. The percentage of lessons reaching the DOK levels two through four was at 63% prior to the one-to-one program implementation and climbed to 63.4% after the implementation. This outcome included all lessons, non-technology-infused lessons and technology-present lessons alike.

H2: There is a difference in the Depth of Knowledge observed in technology-infused lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

As described in Chapter Four, there was a statistically significant difference found in the DOK level observed in the lessons that used technology. The post results increased from 67.9% of lessons with students reaching a DOK level of two through four to a post one-to-one implementation of 81.8%. With an increase of available technology, an expansion of lesson activities that could promote innovation was possible. When technology was shared among teams of teachers and not a one-to-one program, teachers with the reserved technology were often observed giving assessments that required technology. Access to ubiquitous usage of technology devices allowed teachers to plan for incorporating online or computer-based resources at their will without scheduling stipulations.

H3: There is a difference in the levels of the characteristics measured by the SAMR model observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

As described in Chapter Four, there was a statistically significant difference in the distribution of observed SAMR characteristic levels. The shift included a lower percentage of observed substitution level and a higher percentage at the modification level in the year post 1:1 implementation. Observation of a higher percentage of redefinition in the post 1:1 year occurred. The researcher created a Likert-type scale in order to compare the values quantitatively from one year to the other. On a scale ranging from one to four, with one being substitution, two being augmentation, three being modification, and four being redefinition.

Table 24 quantifies the SAMR levels and provides an average score for the 2016-2017 school year.

Table 15

SAMR Levels 2016-2017 Quantified in Overall Score

SAMR LEVEL 2016-2017	Number Observed	Value Given	Points Received	Overall Score
Substitution	58	1	58	
Augmentation	62	2	124	
Modification	7	3	21	
Redefinition	2	4	8	
Total	129		211	1.64

Table 25 quantifies the SAMR levels and provides an average score for the 2017-2018 school year.

Table 16

SAMR Levels 2017-2018 Quantified in Overall Score

SAMR LEVEL 2017-2018	Number Observed	Value Given	Points Received	Overall Score
Substitution	12	1	12	
Augmentation	67	2	134	
Modification	54	3	162	
Redefinition	9	4	36	
Total	142		344	2.42

The analysis of the two years of data showed an overall shift to observation of SAMR characteristics that are higher on the scale. Students participated in higher-level learning experiences because teachers leveraged technology use in order to enhance student comprehension and critical thinking skills.

Possible reasons for the shift to higher SAMR levels may include an increase in professional development geared toward increasing critical thinking for students using technology. Critical thinking, in general, was a focus for the district of study and was linked to the Missouri Educator Evaluation System (2013). Indicator 4.1 in the growth guide evaluates “instructional strategies leading to student engagement in problem-solving and critical thinking” (Missouri Department of Elementary and Secondary Education, 2013, p. 56). The criteria for a distinguished mark included “fluently uses a range of instructional techniques that require critical thinking; serves as a leader by offering constructive assistance and modeling the use of strategies, materials and technology to maximize learning” (Missouri Department of Elementary and Secondary Education, 2013, p. 56). The evidence of committee section of indicator 4.1 stated, “serves as a leader in the use of instructional strategies, materials and technology that maximize student learning” (Missouri Department of Elementary and Secondary Education, 2013, p. 56). The inclusion of technology in this evaluation indicator language is a compelling reason for teachers to consider using technology and pushing up the SAMR ladder. Student learning experiences benefited as a result.

Another possible connection to higher SAMR-level rankings follows the logic that, with ubiquitous access to technology, teachers have students with device-in-hand readily available and they can plan creative and thought-provoking lessons, utilizing all of the 21st century internet, applications, and other technology bells and whistles. The teachers have autonomy over the technology usage and are not beholden to building, district, or state testing on computer requirements. The technology access changed, so the possibilities for usage changed as well.

H4: There is a difference in the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

As described in Chapter Four, there was a statistically significant difference in the distribution of the Learning Activity Type observed prior to one-to-one computer usage and after the implementation of one-to-one computer usage. One stark area of increase was in the category for critical thinking and problem solving, moving from six observed in the 2016-2017 school year, to 29 observed in the 2017-2018 school year. Of the lessons observed using technology, 4.9% of the lessons were critical thinking and problem-solving activities in 2016-2017, compared to 20.4% in the 2017-2018 school year. In the category for research and informational fluency, activities increased from 25.4% prior to the one-to-one implementation, to 32.3% post one-to-one implementation. Additionally, the percentage of lessons observed using technology in general increased from 30.6% of the classrooms in 2016-2017 to 37.1% of the classrooms in the 2017-2018 school year.

H5: There is a difference in the percentage of students engaged with technology prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

As described in Chapter Four, there was a statistically significant difference in the percentage of students engaging with technology in the classroom, with an increase in the percentage post one-to-one implementation. This correlates with the activity type as well as the change toward innovation due to the ubiquity of devices.

H6: The average Likert-type scale rating for teacher responses to survey statements are different than the neutral (3.0).

Statement one prompted, “Students on technological devices are typically engaged during a lesson.” The mean of teacher responses indicated that they felt technology had a positive impact and an overall positive gain. Approximately 82.35% of the respondents chose that they agreed with the statement.

Statement two prompted, “Students can typically reach high Depth of Knowledge levels during lessons while using technology devices.” The mean of teacher responses indicated that they felt that students reached high DOK levels while engaging in lessons that utilized technology. Approximately 82.35% of the respondents chose that they agreed or strongly agreed with the statement.

Statement three prompted, “Teachers can formatively assess students during lessons while students are using technological devices.” The mean of teacher responses indicated that they felt formative assessment was possible while students were using technology devices. One-hundred percent of the respondents chose that they agreed or strongly agreed with the statement.

Statement four prompted, “Students are more distracted during a lesson without a technology device than a lesson with a technology device.” The mean of teacher responses indicated a neutral result. While a spread of responses existed, ranging from strongly disagree to strongly agree, a plurality of the respondents chose neutral (47.06%).

Statement five prompted, “Students take most assessments on technological devices.” The mean of teacher responses indicated to affirm this statement. While 29.41% disagreed with the statement, most of the respondents (64.7%) either agreed or strongly agreed with the statement.

Statement six prompted, “Technology is needed to effectively teach my students.” The mean of teacher responses indicated that they disagreed with this statement. While 47.06% of the respondents chose neutral for this statement, another 47.06% of respondents chose disagree or strongly disagree, shifting the mean to lower than the neutral range.

Statement seven prompted, “Teachers allow technological devices to be used by students the majority of the time in the classroom.” The mean of teacher responses indicated was above the neutral, with 82.35% of respondents agreed or strongly agreed with the statement.

Statement eight prompted, “I see clear benefits for students having individual technological devices in school.” The mean of teacher responses indicated that they felt that this statement was accurate. Overwhelming, 88.23% of the respondents chose agree or strongly agree for this statement.

Statement nine prompted, “I understand the SAMR model and how it relates to students and technology.” The mean of teacher responses indicated that they felt neutral concerning the statement. While many respondents (52.94%) chose either agree or strongly agree, a statistically significant difference, higher or lower, than the neutral 3.0 did not exist.

Statement 10 prompted, “I have received adequate training on designing lessons that incorporate students using technological devices.” The mean of teacher responses indicated that they generally agreed with the statement. A majority (76.47%) of the respondents chose either agree or strongly agree.

Implications

Results for hypothesis one of this study revealed that there was not a statistical difference in the DOK in the day-to-day classrooms between the prior one-to-one laptop year and after the one-to-one laptop year. The introduction of one-to-one laptops did not affect the DOK levels classrooms observed in this study. Approximately 27% of observed classrooms were at a level one for both the pre and post one-to-one laptops, while approximately 67% of observed classrooms were at a level two, three, or four for both the pre and post one-to-one laptops time intervals.

The result suggests that regardless of the technology present in the classroom, the students were performing academic tasks at a consistent school-wide percentage. The overall rigor percentage based on the DOK level one matched closely from one year to the next and was not statistically different. The overall rigor percentage based on the DOK levels two, three, and four, also matched closely from one year to the next and was not statistically different.

Results for hypothesis two specified a shift in the DOK levels in classrooms using technology. Observations from the pre one-to-one laptop program interval revealed 32% at a DOK level 1 and 68% at a level two, three, or four. The post one-to-one laptop program interval revealed that 18% had a DOK level one and 82% at a level two, three, and four. One factor that contributed to this shift involved the freedom of assignment choice that comes hand-in-hand with universal availability of technology. Mandated internet assessment programs often required the utilization of computers and technology resources available within the school.

Results for hypothesis three depicted a significant shift in the SAMR levels observed in the lessons prior to one-to-one and those observed post one-to-one implementation. Again, universal availability played a component in ensuring students would have access so teachers were not technology-restricted in their plans. The decrease in the substitution level indicated teachers were pushing toward levels in which technology may have a stronger impact on the learning experience. In addition, the modification level had a steep increase and the number of observations meeting the redefinition level quadrupled. These shifts indicated that teachers utilized computers more regularly in order to push students toward the transformational levels.

Results for hypothesis four depicted a significant shift in the learning activity types observed in the lessons prior to one-to-one and those observed post one-to-one implementation. While some of the learning types observed were very close in percentage of observations from school year 2016-2017 to school year 2017-2018, others were considerably different.

The learning activity type category with the largest shift was the increase in critical thinking and problem solving, which changed from 4.92% of observed classrooms utilizing technology to 20.42% of classrooms utilizing technology. This can possibly be attributed the ubiquitous nature of the one-to-one program. Different subject areas, including areas that lend themselves to problem-based lessons (such as math and science), had the availability to push out assignments and plan for independent or collaborative work through the technology devices. This may not have been the case for school year 2016-2017.

Many of the learning activity type levels stayed close from year to year as indicated by the percentages. Word processing and math computations, technology operations and concepts, digital citizenship, and assessments each shifted less than 1.50% points from school year 2016-2017 to school year 2017-2018. These items, in particular assessments, continued to be a necessary component within the classroom. These were not the activity types that were highly rigorous or engaging.

Two items had a decreasing percentage. Percentage levels for communication and collaboration, as well as creativity and innovation each decreased from school year 2016-2017 to school year 2017-2018. Communication and collaboration dropped from 18.03% to 8.45% of technology utilizing classrooms observed, while the percentage for creativity and innovation dropped from 16.39% to 5.63% of technology utilizing classrooms observed.

Considerations for School Districts

Following the analysis of results from the study, the researcher had recommendations for the district of study, as well as other districts planning to implement a one-to-one computer program. Based on the teacher perception survey, staff in the district of study had a positive reaction to the one-to-one program in general. However, approximately 47% of the teachers surveyed were neutral or lower about the statement, "I understand the SAMR model and how it relates to students and technology." A recommendation for the district of study is to provide professional development that addresses utilizing SAMR levels when teachers are planning lessons. This professional development should include instructional planning strategies for moving lessons to higher levels on the SAMR ladder. A professional learning structure, such as modeling a task altered for each of the SAMR levels, is an effective way to demonstrate to staff how the different levels of SAMR impact the learning activity for students.

Approximately 24% of the teachers surveyed were neutral or lower about the statement, "I have received adequate training on designing lessons that incorporate students using technological devices." Professional development can be delivered by an educational technology specialist or by teacher peers who are identified as strong in practice. Creating "in-district" resources and supportive staff members to help teachers is a great way to assist everyone while also providing individuals with opportunity to learn, grow, and develop. Through "Ed Camps" and other professional development forums, options connected to understanding and applying one-to-one technology should be offered to teachers over the next serval years. Regular surveys to assess teacher needs in the realm of technology are also recommended.

In addition, offering additional and ongoing professional development for staff is important. For a district deciding to implement a one-to-one program in the future, planning to frontload stakeholders with professional development will help to produce a smooth transition. The year prior, begin professional develop for teachers covering technology platforms (Google Apps for Education, etc.), SAMR levels, rigorous design with technology, and levels of student engagement. For students and parents, offer summer technology workshops that include abbreviated trainings covering the same trainings frontloaded for the staff. Intense planning will increase the potential for a successful one-to-one program launch.

The researcher failed to support Hypothesis One which stated, "There is a difference in the Depth of Knowledge observed in lessons prior to one-to-one computer usage and after the implementation of one-to-one computer usage." The indication was that the rigor of instruction in classrooms, as measure by the DOK level, did not increase or decrease as a result to the one-to-one computer implementation. The researcher recommends continuing current practices for instructional support and professional development in order to maintain consistently high rigor in classrooms throughout the school, regardless of computer usage. Good teaching is good teaching. While the rigor levels of classrooms using technology for a lesson increased after one-to-one implementation, it is recommended that the district of study continue to embed traditional instructional strategies proven to increase rigor.

After year one, the researcher recommends that the school board/administrators perform an assessment of the one-to-one program to determine areas of success or concern. A program evaluation, including survey data from teachers, parents, and students, would benefit future planning on the instructional level and for institutional planning. Regular investigations into what technology devices, software, programs, and platforms are available and would best fit the needs of the students is also recommended.

Recommendations for Future Studies

In this study the focus was on comparing the rigor and engagement levels of students pre- and post- the implementation of a one-to-one computer program. Future studies may include other variables that could be possibly affected as a result of a one-to-one program implementation.

Recommendations for Null Hypotheses may include:

1. There is no difference in the student achievement results observed in student standardized testing prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

2. There is no difference in the socioemotional wellbeing of students prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

3. There is no difference in the behavior of students as measured by office referrals prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

4. There is no difference in students' comprehension and application of Digital Citizenship standards prior to one-to-one computer usage and after the implementation of one-to-one computer usage.

Focus on these variables may bring about further clarity surrounding the various implications and influences a one-to-one program has over students.

Another recommendation for future study moves outside of one-to-one technology programs. Comparative analysis of technology devices, software programs, and digital platforms may offer insight about the impact each has on students.

Recommendations for Null Hypotheses may include:

5. There is no difference in student achievement scores when comparing tablet, Chromebook, and MacBook usage.

6. There is no difference in student achievement scores when comparing Evaluate, Galileo, and eDoctrina educational and data software.

7. There is no difference in student achievement scores when comparing digital platforms such as Google Classroom, Canvas, and Blackboard.

Finally, the researcher would recommend that this study be replicated for school levels other than middle school. Further research is needed to uncover the intricacies that ubiquitous computer access for young children at their formative stages in education would bring. This study would be of interest to the school districts considering a one-to-one program for lower grades. Replication at the high school level would also clarify the spectrum of influence computers have on students at different stages of childhood.

Conclusion

As technology continues to grow into a necessary component of society, it will be a key component in education. Through sound educational practices and pedagogy that supports rigor and engagement, students will be able to learn at high levels with or without technology. Ongoing professional development around the ever-changing field of educational technology will empower teachers to leverage technology tools in order to support and supplement lessons.

The department of education and the statewide and local school boards all have roles to play to ensure that students are learning at high levels as a direct result of the digital learning experiences. At the national level, providing funding for equitable allocation of technology will support the diverse needs of students throughout the country. At the state level, implementing course standards that promote rigor and engagement will increase student achievement. And finally, local school boards can utilize data to ensure that educational technology trends, including one-to-one programs, are appropriately supporting the needs of their student constituents. Students are more connected with the world than ever before. Proper direction and leadership will ensure they can successfully navigate the digital landscape and became productive citizens in future society.

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Appendix A

Survey Tool

The researcher used a Likert-type scale for the scoring of the responses ranging from one to five (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) considering the following statements:

Students on technological devices are typically engaged during a lesson.

Students can typically reach high Depth of Knowledge levels during lessons while using technology devices.

Teachers can formatively assess students during lessons while students are using technological devices.

Students are more distracted during a lesson without a technology device than a lesson with a technology device.

Students take most assessments on technological devices.

Technology is needed to effectively teach my students.

Teachers allow technological devices to be used by students the majority of the time in the classroom

I see clear benefits for students having individual technological devices in school.

I understand the SAMR model and how it relates to students and technology.

I have received adequate training on designing lessons that incorporate students using technological devices.

Appendix B

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Matthew Mooney** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 04/09/2014

Certification Number: 1445768