2018

Teacher Practices and Behaviors That Increase Student Achievement When Implementing 1:1 Technology in the Classroom

Jared P. Jacobs
Bethel University

TEACHER PRACTICES AND BEHAVIORS THAT INCREASE STUDENT ACHIEVEMENT WHEN IMPLEMENTING 1:1 TECHNOLOGY IN THE CLASSROOM

A MASTER'S THESIS

SUBMITTED TO THE FACULTY

OF BETHEL UNIVERSITY

BY

JARED JACOBS

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF ARTS IN EDUCATION

SEPTEMBER 2018

BETHEL UNIVERSITY

TEACHER PRACTICES AND BEHAVIORS THAT INCREASE STUDENT ACHIEVEMENT WHEN IMPLEMENTING 1:1 TECHNOLOGY IN THE CLASSROOM

Jared Jacobs

September 2018

APPROVED

Thesis Advisor: Nathan Elliott, M.A.

Program Director: Molly Wickam, Ph. D.

Acknowledgements

I would like to thank my advisor, Nathan Elliott, for being patient with me through the long and disjointed process of writing this thesis with me. In offering feedback and advice through numerous revisions he has helped me become a better researcher, writer, and educator. In offering encouragement to stick with my chosen topic I had the opportunity to learn more about a subject matter that is relevant to day-to-day life in my classroom. I would also like to thank my friends and family who have encouraged and supported me through my transition from bank employee to teacher. I could not have done it without you all.

Abstract

This paper examines the research related to the impact of 1:1 technology initiatives on student achievement. There are studies that show students using 1:1 technology have improved test scores in a variety of subjects, and there is literature that highlights specific methods for using 1:1 technology in the classroom. Many different opportunities for improved instruction are explored which break down into four main categories; increasing the amount of time students spend in class, 21st century skills, assistance to all learners, and advanced pedagogy. Additionally, different challenges that must be overcome in order to implement a strong 1:1 technology program are explored, which break down into three categories: teacher challenges, student challenges and administrative challenges. It is determined that the biggest key to implementing a 1:1 program is a staff that is enthusiastic and motivated to use 1:1 in their classrooms and who are also equipped with ongoing professional development in order to best make use of devices.

Table of Contents

CHAPTER I: INTRODUCTION

In the early 19th century the US economy shifted from an agricultural focus to an industrial focus, which caused the population to change from a more dispersed rural population to one more concentrated in cities. As a result, educational practice had to change. Similarly, the current US economy is shifting away from its former industrial focus to industries that are idea-driven and creative in nature (Spires, Weibe, Young, Hollerbrands, & Lee, 2009). To prepare students for today's shifting economic environment, schools need to be ready to adapt to expectations from society, politicians, and customers, and one way they are going about that is through increasing the use of technology in the classroom (Lane, Lemoine, Tinney, & Richardson, 2014). School districts looking for ways to help their students achieve at higher levels are turning to *one-to-*one *technology* as a method of accomplishing this goal (Harris, Al-Bataineh, & Al-Bataineh, 2016). When a district implements 1:1 technology it provides a computerized device, most commonly a laptop or tablet, that students have access to at all times, and with the ubiquity of mobile-technology the devices are often small mobile devices that students can take home with them. The classroom will have these devices every day without having to worry about a computer lab or laptop cart being reserved by another teacher. Giving students a device that they are responsible for ensures that each student has access to a device in every class they take, and enables the student to bring the device home with them after school, providing students with access to the same materials and tools throughout the day.

Another term for a 1:1 technology program that utilizes mobile devices, as found in much of the reviewed literature, is m-learning or *mobile-learning*. A well-structured 1:1 classroom has the resources to create new educational experiences with greater potential to empower student learning. Ultimately, a major selling point of 1:1 technology is that it provides students with

more opportunities to build the type of flexible, self-sufficient skills that are often called upon to succeed in the USA's shifting economy (Bebell & O'Dwyer, 2010).

As a relatively new educator teaching business and technology courses, I have already had significant experience with 1:1 technology in the classroom. As a student teacher, I was at a school that did not feature 1:1 technology, and I often found myself trying to utilize online resources that could not be fully accessed by all students, leaving me with the choice of skipping tools that would enrich my lesson or implementing them anyway knowing that not all students would get the same benefit. When looking for my first full-time teaching job, I focused my search on schools with 1:1 technology programs. Accepting a position at such a school, I found that properly using 1:1 technology to help increase student achievement proved more challenging than anticipated. I found that devices, whether they are iPads or Chromebooks, are not magic wands that enrich students by merely being present in the classroom. I found many teachers were extremely frustrated by all the technology, and the minimal benefit they derived from the devices was far eclipsed by how distracting they were for the students. I found frustrated parents whose children were using their devices for gaming, social media, and anything but homework, who could not understand why the school district invested so much money into the 1:1 technology program. I found a problem that needed a solution.

Defining Digital Natives

Digital natives is a term used to describe a person or group of people who grew up during a time where digital technology and the internet were widely and commonly used. The prevailing assumption is that digital natives have a more intuitive understanding of technology because they grew up with it, and therefore, it is part of their normal experience rather than a new skill to be learned. All students today are considered digital natives as well as young teachers and college

graduates just joining the profession. As such, it is assumed that current students and young teachers have natural experience and enthusiasm for technology and are more suited towards using it in the classroom, although that assumption is not always accurate.

Defining the SAMR Model

The SAMR Model, which stands for Substitution, Augmentation, Modification and Redefinition, is a model for how teachers can integrate 1:1 technology in the classroom (Romrell, Kidder, & Wood, 2014). Substitution and Augmentation are low-level technology adaptations, which makes aspects of the class more convenient, but do not add new value to the educational experience. Some examples include posting a syllabus online or giving a multiple test choice online. These adaptations make materials more conveniently accessed and in the case of an online quiz can provide students with instant feedback on their performance, so they do have value. However, if that is all a teacher does with 1:1 technology, the SAMR Model argues that they are not fulfilling the device's potential for increased student learning (Romrell et al., 2014).

The SAMR model provides guidance for teachers who work in 1:1 classrooms to reach for more meaningful pedagogical uses of 1:1 technology. Pedagogical tasks that would be difficult or impossible without technology, such as creating video presentations on a topic covered in class, give students more opportunities to apply the lessons they've learned and prove mastery of material.

Defining Teacher Buy-in

Buy-in is a term that, in the context of this paper, indicates a person's willingness and enthusiasm to engage with something. In the school setting, buy-in indicates that the teachers and administration are on the same page and that they agree on whatever course of action is being

taken to improve education for their students. When introducing 1:1 technology to school systems it is vital for teachers to be invested in using the devices and for them to see the benefit of learning how to implement this technology in their classrooms, because they are the ones who need to learn how to utilize and rework their lesson plans to include the technology in a meaningful way.

Research Question

The perplexing fact of 1:1 laptop programs is that, despite numerous studies, there are no clear guidelines for how to implement programs for the best results (Howard & Rennie, 2013). By reviewing many studies done on 1:1 technology and m-learning programs implemented in schools of all grade levels throughout the world, this paper will explore answers to two different questions: Is there any evidence that 1:1 technology programs have an impact, positively or negatively, on student achievement? And, what are some specific practices that teachers and administrators can utilize in order to both take advantage of the opportunities a 1:1 technology program can offer and avoid the obstacles that implementing a 1:1 technology program can present?

It is clear that the movement towards 1:1 technology programs has a lot of momentum now, which makes the materials of this paper an area of high need. It is therefore of paramount importance that school districts are thoughtful and deliberate about how they implement their 1:1 initiatives. Examining the literature related to 1:1 technology and m-learning programs and the many aspects of the classroom that they impact will do more than simply answer whether or not such programs can boost student achievement; it examines the specific ways a program can be implemented to bring about that achievement.

CHAPTER II: LITERATURE REVIEW

A literature review will attempt to determine whether 1:1 technology in the classroom can help boost student achievement. It will also address what teacher or administration practices can be used to ensure that 1:1 technology is being used towards the goal of student achievement and not detracting from it. The review will focus on schools that implemented various forms of 1:1 technology such as laptops, cell phones, and tablets such as iPads. The studies will focus on how the students perform after the 1:1 technology initiative rolls out. Students from all grades and abilities will be considered, as 1:1 technology is something that affects students of all levels.

It is not enough to merely determine if the effect of 1:1 technology is positive or not. An initiative giving students access to the information, production, and creative tools that technology is capable of is a complicated venture with lots of possible strategies and variables that can play a role in the efficacy of the initiative. The word *access* is qualified, because simply having access to information and tools does not mean necessarily that the access will result in productive teaching and learning outcomes. Nevertheless, if each student has a mobile learning technology device and access to the Internet, the conditions for learning are fundamentally altered (Spires et al, 2009). In addition to determining the efficacy of 1:1 technology in the classroom on student achievement, this thesis will also attempt to determine which practices lead to positive results in the classroom and which strategies or lack thereof impeded the progress of students. Discovering the best methods to utilize 1:1 technology in the classroom is knowledge that stands to be of benefit to any teacher involved in such a program.

The Literature Review will be broken into two different sections; a section outlining the benefits and opportunities 1:1 technology offers to a classroom, and another outlining the

challenges such an undertaking presents. Both the opportunity section and the challenges section will be comprised of multiple sub-sections that explore research on focused topics.

Opportunities

This section of the literature review will examine many of the different opportunities that 1:1 technology can offer students. The impact of 1:1 technology on many different aspects of the classroom will be detailed before examining whether or not any of these opportunities lead to any tangible results in student achievement.

Motivation and Engagement

Much of the literature focused on whether or not 1:1 technology had any impact on student motivation and engagement. Many researchers agree that it does, stating that technology utilized in the classroom is indeed motivating and engaging for students. (Backer, 2010; Jones & Issroff, 2007; Kukulska-Hulme & de los Arcos, 2011; Pachler et al., 2010; Pegrum, 2013). In particular, comments about students' faces 'lighting up' when iPads are brought out, and teacher enthusiasm for integrating technology in lesson plans are referenced in interviews conducted by Pegrum, Oakley, and Faulkner (2013). These interviews were part of a study conducted in nine schools encompassing all age groups in Western Australia in 2011 as part of a movement to research the efficacy of mobile devices on students' ability to learn and teachers' ability to teach. Through interviews with principals, teachers, and IT support staff it was noted that students responded to the inclusion of 1:1 devices with enthusiasm and motivation. While the data is only derived from staff and not students and it was conducted outside of the U.S., the study still provides valuable insight into how the early adopters focused on using the 1:1 technology with a focus on pedagogy.

In 2011, Cavanaugh, Dawson, and Ritzhaupt conducted a study of 47 K-12 schools in Florida with the goal of determining whether or not student-achievement was boosted by the use of laptop technology, professional development for teachers to help them utilize this technology, and proper administrative support for the technology. In particular, the researchers were looking for evidence to see if teaching became more student-centered and tool-based after providing laptops to all students and proper support to the teachers. One of the methods of collecting data was through classroom observations utilizing two different nationally recognized standards, School Observation Measure (SOM) and Survey of Computer Use (SCU). These methods, conducted by over 70 Florida teachers trained to use them, specifically tracked the extent of alternative teaching methods as well the types of technology used in the classroom, their configuration, and how they were exactly used. Each of the 47 schools was observed both in the Fall and Spring semesters, totaling 381 observation hours in the classrooms of 481 teachers responsible for educating approximately 8,500 students. The observations took place in 15-minute increments and were randomly chosen and unannounced in order to get an authentic view of how the technology was utilized on a day-to-day basis. The observations were supplemented by teacher inquiry surveys based off of Dana and Yendol-Silva's inquiry method, as standardized tests are a tough way of measuring technology use in the classroom. After spending an entire school year collecting qualitative data in 440 classrooms, Cavanaugh et al. (2011) reported that over 60% of teachers saw an increase in learning among their students, including motivation and engagement. The strengths of this study include the sheer numbers of schools, students, and observation hours, as well as the study being conducted over the course of an entire school year. The findings of this study could be improved by another study focusing on teaching practices and creative uses of technology that result in the best possible learner outcomes.

In a synthesis of four empirical studies that looked at K-12 1:1 programs, Bebell and O'Dwyer (2010) looked for themes that emerged from comparing the studies and found, "Despite variations between and across 1:1 settings, participation in the 1:1 programs described was associated with increased student and teacher technology use, increased student engagement and interest level, and modest increases in student achievement" (p. 11-12). In a study comparing and contrasting 1:1 classrooms with classrooms that share a laptop cart with other classrooms, Russell, Bebell, and Huggins (2004) found over the course of fifty-six classroom observations that on a scale that ranged from 1 (no engagement) to 5 (high engagement), mean level of engagement for students in the 1:1 classrooms was 3.8 as compared to 3.3 in the shared classrooms, a difference that is statistically significant at the .05 level.

Discipline and Attendance

One of the benefits of increased student engagement is the effect on attendance and amount of disciplinary actions needed for students in classrooms that utilize 1:1 technology. Rosen, Yagal, and Dawne (2012) ran a study on the impact of 1:1 technology on student motivation and attitudes towards learning in comparison to traditional classroom settings. They used standardized assessment scores, school records for attendance and disciplinary incidents, surveys from students and conducted observations in classrooms utilizing 1:1 technology as well as control group classrooms without the technology. Records were taken at the beginning and end of the year to gain a sense of progress throughout the year. This data all came from fourth and fifth grade classrooms from four different schools in a school district near Dallas. At the conclusion of their study, Rosen et al. (2012) found that there was a reduction of 29.2% in unexcused absences from the beginning to the end of the year compared to a control group that had their absences increase by 56.6%, saving the district $116.88 per student per school year.

Similarly, they noted a decrease in discipline rates by 62.5% compared to the control group's decrease of 15.4%. The strengths of this study include verifiable data from school districts that show that students in 1:1 classrooms came to class more often and required lesson disciplinary intervention compared to classrooms that did not. These factors seem to be strongly tied to each other. However, the fact that the study was limited to 4th and 5th grade students means that it will be difficult to predict similar results in students from different age groups.

Student Centered Practices & Reducing Direct Instruction

A growing trend in education is to reduce the amount of time that a teacher spends lecturing and increase the amount of time that students are actively learning material. This engages students at higher levels of Blooms Taxonomy. Rosen et al. (2012) focused on finding out the impact of 1:1 technology on motivation. They found a correlation between 1:1 technology use and the amount of time the class engaged in student centered practices. The findings indicated that on average, 40.3 one-to-one student-teacher interactions were observed in the experimental classes during the third and fourth months of the school year (23.5 teacher and 16.8 student initiated), whereas 17.0 interactions on average were observed in the control classes (15.3 teacher and 1.7 student initiated). During the eighth and ninth months of the school year, the average frequency of teacher-student interactions was 51 in the experimental classes (30.0 teacher and 21.0 student initiated), whereas 30 interactions on average were observed in the control classes (12.0 teacher and 18.0 student initiated) (Rosen et al., 2012).

Holcomb (2009) conducted a collective review of 31 different studies that focused on 1:1 technology in the classroom. Holcomb did not focus on any one particular aspect but rather covered a wide spectrum including both the positive and negative impacts the practice 1:1 technology has on students and teachers. By conducting the study on this large scale Holcomb is

able to note observations in common elements found by different researchers, giving a more clear picture on the effects of 1:1 technology over a variety of different implementations. Unfortunately, the study is only six pages long and therefore lacks the space to properly dive into all the sources drawn upon and find as many connections as possible. A number of researchers agree that 1:1 technology helped students stay organized and interested in learning which resulted in a higher amount of time spent engaged in their own learning, project based learning, and increased self-editing and correcting, with between 70% to 80% of students verifying this information in each of these surveys (Gulek & Demirtas, 2005; Lowther, Ross, Strahl, Inan & Pollard, 2009; Silvernail & Gritter, 2007; Silvernail & Lane, as cited in Holcomb, 2004).

Despite technology's reputation for isolating people, there is evidence that 1:1 technology in the classroom results in increased collaboration between students. Corn, Tagsold and Patel (2011) conducted a study looking at the effects of a 1:1 initiative that took place over the span of 18 high schools in North Carolina containing 9,500 students and 600 staff members over the course of three years. In a comprehensive study involving surveys, focus groups, classroom observations, analyzing repair and inventory checklists, reviewing lesson plans, as well as attendance and discipline records, they set out to study the proficiency of infrastructure and support systems in meeting educational needs, how the staff and teachers' attitude, skill, and instructional practices changed over time, and how students' 21st century skills, learning and achievement changed over time. The wide span of this study in terms of subjects, methodology, and time is a large strength of this study but its results are limited to high schools, ten of which are college-prep high schools which could skew the type of student in this schools. In interviews conducted in North Carolina, teachers found that their experience with 1:1 laptops assisted in making the classroom a more collaborative experience. As one teacher explained, "It's that

giving up control and just being one of them and we're in this together, I'm going to facilitate this, we're going to get into groups and just figure it out as we go… that's a new way to look at teaching" (Corn et al., 2011, p. 14). A major change that students experienced in 1:1 learning was an increase in small-group or individual learning activities (Corn et al., 2011). The students were more empowered to learn themselves and from each other as comfort with 1:1 technology was built.

While the above findings are quantitative in nature, there are many more qualitative studies based on researcher's observations and teachers' self-reported results. The results of these mirror the quantitative data above. Pegrum et al. (2013) noted that interviews with teachers backed up what the general consensus on learning with mobile devices in the classroom; it helped cause a paradigm shift from the 'sage-on-the-stage' model of pedagogy to a more student focused, collaborative model. Further, the apps valued most by teachers and students were those that were creative in nature and allowed students to tell their own stories. Such examples included Comic Life, Puppet Pals, iMovie and GarageBand. Similarly, Holcomb (2009) observed in two different studies that teachers in laptop schools showed significant movement towards constructivist teaching and were more likely to encourage student-lead inquiry and collaborative work and that teachers were able to transition to role of coach/facilitator in the vast majority of observed classrooms. A shift towards more student-centered strategies was also observed.

Switching to this style of instruction is not without merit, achieving this model has shown positive effects in the classroom. Serin (2011) used two different focus groups of 26 students each, 52 total, in the fifth grade to investigate the effects of the computer-based instruction on the ability to solve-problems in science and technology classes. The model of using pre-tests and posttests with a control group model gives very relevant feedback as to what kind of impact the

technology had, however the small sample size and limited amount of time spent conducting the study, two units, is a limitation to the universal applicability of the results, which indicated that providing students with technology had a positive impact on student learning. In particular it was found out the use of the computer and the teaching package with the materials such as videos, slides, CD's, sounds and animations in the science and technology course makes it possible to have an interactive lesson. Moreover, the presentations of topics by means of rich visual materials increase the achievements of the students (Serin, 2011). Even school administrators appreciated the change in the dynamic of the way students are learning in the classroom, stating "Students began thinking about their own thinking" (Corn, 2011, p. 14) when taking part in a 1:1 classroom that wasn't driven by teachers delivering all the content.

Yet another method of keeping learning student centered is through the use of extension activities to make use of the free time students who complete assignments and tests early. Corn et al. (2011) noticed this done to good effect in an English class where students who completed their tests early were directed to a website that allowed them to do more in-depth research on books the class had previously read or other books the student is interested in. When interviewed the teachers felt that this was a more efficient use of class time that was beneficial to student learning.

Howard and Rennie (2013), rather than conducting a study on the efficacy of 1:1 computing, set out to determine specific methods 1:1 programs can use to increase pedagogy. They collected information by drawing on interviews and online discussion posts from 20 randomly chosen teachers from nine different schools that have 1:1 laptop programs who had gone through a training program to better use them in the classroom. The strengths of the study included an attempt to look deeper into the pedagogical impact and asssurance that the teachers interviewed

had training in how to implement 1:1 technology in the classroom, as to illicit more informed feedback. Weaknesses included a lack focus on student issues – grade level impact, attendance, and how student training on devices varied. At the end of the study they concluded that teacher-focuses tasks utilizing 1:1 technology were not sufficient to get students to engage in higher level thinking, 1:1 technology is at its best when it is student-centered.

Communication

Students having access to their own devices has shown to have benefits when it comes to communication between students and teachers. Corn et al. (2011) found in a study of 18 secondary schools that laptops facilitated more communication between students and teachers. Some specific instances of this included students not having to leave their desks and walk to the front of the room to 'speak' with the teacher, shy students feeling more comfortable sending a message rather than meeting with a teacher face to face, and the ability for students to ask questions and get caught up on assignments outside of school hours. Students were also able to stay more up to date and informed on their grades this way.

Communication between students and teachers isn't the only communication channel Corn et al. (2011) noticed. Students increased communication between peers as well. Absenteeism was no longer an excuse to avoid doing work as emailing notes and missed assignments to missing classmates helped them stay up to date. Additionally, students could use email, chat apps, and message boards to continue to collaborate on homework after the school day was over.

The idea of mobile devices being used as a method for communication in the classroom was explored further in a study conducted by Rau, Gao, and Wu (2008). They set out to study how students in vocational schools in Taiwan, with the focus of preparing their students for

placement in the workforce upon graduation, benefitted from using mobile-technology as a form of communication, mainly through text messages, email, and online class forums, in regards to motivation, student pressure, and learning performance. In order to accomplish this they conducted an experiment dividing students equally into four different groups that each used a different form of media to receive their assignments; text messages, emails, online forums, and a no media control group. Care was taken to ensure no group was a higher performing academic group than any other. Over a three-week span covering one chapter from a Computer Literacy class, 176 high school students began receiving after-lecture learning materials by their groups form of media, or face-to-face for the control group. Before and after the chapter, students filled out a questionnaire describing their learning motivation and pressure, and students received academic quizzes at the end of the week. At the conclusion of the chapter it was found that there appeared to be a positive impact on motivation without any increase in pressure when using a form of mobile technology. While each method of communication had its own pros and cons, they all appeared to positively impact the students' relationship with the teachers, with texting deepening the bond the most while the online forum and email being better for transferring large amounts of data, which suggests that mixing multiple forms of communication could be the most beneficial. The study is strong due to how it directly compares and contrasts different forms of technological communication while having a non-tech control group. It does suffer from a very short time period for the experiment, and the results found in one culture may not transfer directly to another culture if that culture stresses a different type of relationship between students and teachers than the Taiwan culture does, Rau et al., (2009).

Formative Assessment

One area in which 1:1 technology can be beneficial to the classroom is Formative Assessment. Formative Assessment is a classroom practice where the teacher quickly determines how well each individual student is grasping the material without giving a grade. A teacher who can do a quick and effective formative assessment can determine whether topics need to be retaught on a large scale, if the entire class is ready to move on, or if some differentiation is needed in the classroom. Using Formative Assessment in the classroom is a popular trend in education to help students reach learning goals and prepare to do well on summative assessments.

Dunleavy, Dextert and Heinecket (2007), conducted a study with the goal of studying 1:1 computer programs in the classroom not to see if they had an impact on student achievement but rather to see how exactly they were being utilized to add value to classroom proceedings. Eight different teachers in a middle school setting (6^{th}-8^{th} grade) who taught core classes in the south-eastern United States were chosen as the subjects for this study. Each teacher was specifically chosen due to the reputation of their 1:1 computing programs. The schools and teachers were picked based on recommendations of administrators as well as a record of high achievement on standardized test scores. A team of researchers spent over 130 hours over the course of a semester conducting interviews, observing classroom activities and reviewing documents. One of their findings was that including 1:1 technology in the classroom increased the frequency and quality of formative assessments, giving teachers more chances to check on their students' understanding and assign them their next activity. In fact the researchers found that the 1:1 technology was so essential to quality formative assessments that they noted "The real-time monitoring of students' understanding represented in observations of this study would be

impossible without a 1:1 environment" (Dunleavy et al., 2007, p. 449). Students can quickly access and turn in quizzes electronically, search for images, videos or articles that support their claims, or create a piece of media that quickly informs the teacher of their level of understanding. While the study is limited in that it only focuses on teachers and classrooms with a record of high achievement this actually serves the study well as it showcases the best examples of 1:1 utilization that any teacher could utilize in their classroom. A real limitation of the study is that it only focuses on eight teachers, a small amount when compared to many of the studies on the subject. The inclusion of more quality teachers could have enabled the researchers to find more quality practices.

Gerber and Ward (2016) conducted a study reviewing thirteen different studies with the intent of highlighting some effective uses of 1:1 technology. Through the review of literature they made suggestions on how screen casting apps, graphing calculator apps, and student response apps. The wide range of research drawn upon and practical suggestions provided are a strength of the study whereas a lack of statistical data showing he efficacy of these practices on student outcome are weaknesses of the study. Of the methods outlined by the study, Student Response Systems have been shown to be very useful in conducting quick and useful formative assessments during class. These are things such as clicker systems or apps that allow students to individually respond to prompts through the app, usually by clicking a button. The responses are aggregated and displayed for quick analysis by everyone in the classroom. This allows teachers to quickly see how every student in the classroom is doing without having to worry about overly shy students or students who always want to answer questions. The end result is that the teacher has a pulse on the learning of the class and can more confidently decide if a class is ready to move on or if they need more time to review or practice a concept. Furthermore, teachers can

also use the same technology as an "exit ticket" procedure which allows students to summarize what they learned in class as well as what they found confusing. Additional benefits of these apps include the ability to allow students to leave anonymous feedback, which is often more honest, as well as their ability to make a passive lecture more active and engaging.

Flexible Learning Spaces

Often, when implementing a 1:1 program, the devices are often iPads, laptops, and cell phones. In other words, the devices are mobile. This presents all sorts of opportunities for learning beyond a traditional classroom setting. There is little research to be found on whether or not that mobility helps within the confines of the classroom. In fact, one school, responding to this newfound freedom, was setting up flexible classrooms with no fixed desks in order to foster collaboration and communication between students – a change which some teachers were finding challenging (Pegrum et al., 2013). That isn't to say that there aren't any benefits to be found from utilizing the mobile nature of 1:1 technology. Holcomb (2009) noted that the most effective model of utilizing 1:1 technology is a concentrated model where the students have their own devices that they can take home with them. Twenty-four hour a day access allows teachers to extend the homework devices as well without having to worry about the students' home situation. Students who were part of a concentrated model reported spending more time doing homework on the computer and more time engaged in learning activities outside of school compared to those who did not have continuous access to a laptop (Muir et al., 2004a; Muir, Knezek, & Christensen, 2004b, as cited by Holcomb, 2009). These findings emphasize the importance of ensuring that the devices are mobile and that administration implements a policy that allows the students to take the devices home. Keeping them rooted to the classroom only,

such as carts of iPads or Chromebooks, while more cost effective, misses out on one of the major advantages of implementing a 1:1 technology program.

Another popular trend in education is utilizing flipped classrooms, a method where the student is responsible for learning the primary content outside of class and classroom time is used by the teacher to help students engage with and fully grasp the material. In a 2017 study, Jakobsen and Knetemann set out to study the developing practice of Flipped Classrooms. Though their analysis of multiple studies on the topic didn't directly touch on 1:1 technology, a portion of their research addressed the ways in which 1:1 technology can help to implement flipped classroom techniques. While this study does lack primary research and specificity on age ranges, it does draw on the findings of multiple researchers to back its conclusions, and it focuses on a very practical use of 1:1 technology. In their study of flipped classrooms, Jakobsen and Knetemann (2017) found evidence that it could have positive impacts on student outcomes, particularly if team-based learning principles were used when structuring the classroom. Although not reliant on technology, they acknowledge the advantages of technology, noting the ability to watch, pause, and rewind videos at individuals' own pace, as well as the ability to access information easily from home multiple times. A 1:1 technology strategy therefore makes a potentially effective compliment to a flipped classroom as the teacher can reliably know the students will have access to the proper technology at home and they do not have to account for the wide variety of devices a student might use but rather tailor the assigned content to the device provided by the school.

SPED, ELL and Students with Hardships

Students having access to devices has proven invaluable to students with disabilities. Pegrum et al. (2013) found that students with visual impairments or dyslexia can use programs

that resize and reformat text as well as utilizing voice recognition and text-to-speech apps. The study also noted that three different schools mentioned that there were benefits to students with special needs, including those requiring early intervention or who struggle with curriculum.

Taj, Sulin, Sipra and Ahmand (2016) conducted meta-analysis on 13 different studies between the years of 2008 to 2015 looking at how technology impacts English language learners. These studies all had to use an experimental method, a pretest and posttest design with a control group, and used electronic devices for interventions. By ensuring all the studies reference in the meta-analysis met these standards, Taj et al. (2016) ensured that they had high quality scientific data from a variety of sources that were able to confirm results. While this methodology results in high quality quantitative data, there is little qualitative data to speak of that might help to shed light on best practices when it comes to implementation. After analyzing the data it was found that the use of technology to assist English Language Learners had a positive impact on their ability to master the language. With an effect size of .425 over the 13 cited studies, each of which were positive in their own right, it seems clear that teachers in ELL classrooms have put devices to good use. Furthermore, Taj et al. (2016) found no discrepancy in results in regards to grade level or sample size; all ages and all class sizes benefitted from using devices.

There are conflicting opinions on the efficacy of 1:1 technology when considering students from different socio-economic backgrounds. In a study commissioned by the Denver School of Science and Technology to study the efficacy of their 1:1 laptop program, Zucker and Hug (2007) interviewed a faculty member who said “The 1:1 laptop program is a critically important element of our college preparatory program. It ‘levels the playing field’ between students across the economic spectrum. It gives all students access to the same data and develops technological skills essential to higher education and the world of work” (p. 27). This

interview was one of many in a series of one on one interviews, focus groups, classroom observations, document reviews and surveys of 32 teachers and 428 students in a Denver High School looking to see how the technology was used and whether or not it helped reach benchmarks. As the quote above indicates, Zucker and Hug (2007) found that many of the students and staff spoke glowingly of the technology's ability to level the playing field for all students. Alternatively, Warschauer (as cited in Holcomb, 2009), finds that students who were prepared and encouraged to go to college from an early age were more successful in 1:1 laptop programs than students from low SES neighborhoods who were less likely to have a strong research focus or the critical and analytic skills necessary for such initiatives.

21st Century Skills

While standardized test results are of immense importance to school districts, another commonly cited goal among schools is to prepare students for what work will be like in today's society, and the ability to utilize technology is an important aspect of this. In a study by Spires et al., (2009), a literature review was conducted with the purpose of speaking towards the shift in teaching and learning that is being brought about by the growing ubiquity of 1:1 technology programs and how teachers can go about harnessing these new tools to create a classroom environment the enriches student learning. In their review of 56 different studies they focused on four different factors of the new learning environment; immediate access to information, personalized learning, highly developed teacher capacities, and highly developed student capacities as well as five different professional development areas for teachers. The strengths of the study include a nuanced and multi-faceted view of the way 1:1 technology can transform a classroom and detailed ways to develop teachers to be able to take full advantage of a 1:1 program's potential. Its weakness is that it is all qualitative, and there is little data that speaks

towards the efficacy of these programs. In the study they defined 21st century skills as innovation, creativity, problem solving and collaboration, citing the Partnership of 21st Century Skills and the International Society for Technology in Education. While these are desirable skills in all classrooms not just those with 1:1 programs, the authors note that "the difference for students and teachers in 1:1 classrooms, however, is that they have the distinct advantage of immediate and constant access to information and a global community – and communication, productivity and creativity tools" (Spires et al., 2009, p. 235).

Corn et al. (2011) reported in a study conducted on one school's 1:1 program, all teachers noted an increase in student typing and technology skills, including file and folder management, e-mail attachments, and the ethics of digital citizenship. One teacher reported, "They're learning how to appropriately behave in a digital world" (p. 17). This skill is especially important for digital learners of the 21st century. Additionally, interview and focus group data suggested that teachers started implementing lessons that were more creative and that gave students a more authentic experience once they mastered the technology. It was not an easy process to bring this about, as it took a significant amount of time and effort to convert old lesson plans and develop brand new ones, but after this initial phase the workload and time commitment returned to more manageable levels of small tweaks in order to perfect a lesson or adapt it for new classes (Corn et al., 2011).

Student Achievement

A number of studies have been conducted on the topic of student achievement, many of which featured an experimental classroom acquiring 1:1 technology being compared to a control group classroom of peers learning the same material in a traditional classroom setting.

Crook et al. (2014), set out to see if there was any difference in science scores between a groups of students given 1:1 technology and a control group that was not. This study encompassed 967 high school students from 12 different schools, and followed them throughout a three-year span. While the study lacked a look into implementation techniques that would be of use to teachers looking to utilize 1:1 technology in their own teaching, it does offer a lot of quantitate data and statistical analysis over a long period of time. After three years of data collection, classroom observations, and focus groups, it was found that the classrooms with 1:1 technology showed medium effect size in physics (0.38), and small effect sizes in biology (0.26) and chemistry (0.23) (Crook et al., 2014). In a different study by Rosen et al. (2012), fourth grade experimental students significantly outperformed the control students in reading scores (M = 621.9 compared with 665.9) and in math scores (M = 597.6 compared with 673.9) (Rosen et al., 2012). Fifth grade experimental students significantly outperformed the control students in reading scores (M = 652.5 compared with 713.7) and in math scores (M = 654.7 compared with 700.6) (Rosen et al., 2012). To further corroborate, Bebell and O'Dwyer, (2010) found that 7th grade students in their second year of the 1:1 program showed statistically significant gains on ELA standardized scores compared to students who did not have 1:1 technology in their classrooms, even after controlling for prior ELA achievements. Bebell and O'Dwyer (2010) also note that in a study by Suhr, Hernandez, Grimes, and Warschauer (2010), that over the course of two years a group of fourth graders who entered a laptop program had higher test scores in ELA as compared to a group of students who entered a more traditional program in the same district. Specifically, the 1:1 students had higher gains on the ELA test and on the subtests related to writing strategies as well as literary response and analysis than the non-1:1 students (Bebell & O'Dwyer, 2010). Similarly, in a study by Holcomb (2009), it was found that students in the 1:1

program earned significantly higher test scores and grades for writing, English-language arts, mathematics, and overall grade point averages than students in non-1:1 programs. Jeroski (as cited in Holcomb, 2009) reports that when a group of students was given laptops the number of students who met performance standards over the course of one year increased by 22 percent.

Teachers also have noted the positive impact of 1:1 technology in the classroom. In a study by Cavanaugh et al. (2011), 78 percent of teachers said they documented changes in their students' achievement which includes test scores, higher level thinking skills, retention, and transfer of learning.

Although there are a lot of findings that show the efficacy of 1:1 technology in the classroom, not every study found positive results. Holcomb (2009) found that in Liverpool, NY, a 1:1 program was terminated after 7 years as there was little evidence of an impact on student achievement. A similar control group study, conducted by Harris et al. (2016), looked at different 4th grade classrooms in the same low-income school with a diverse population. One classroom was given 1:1 technology to utilize while the other was a control group without it. The researchers measured motivation through attendance records while performance on The Discovery Education Assessment was used to measure student achievement. At the end of their research they found that on some tests the 1:1 classroom much higher than the control group, but on others the inverse was true. Nothing conclusive was found. While the control group format is a strong one this study was performed on a small scale. Tying motivation solely to attendance and achievement solely to a standardized tests is not fully indicative of these qualities (Harris et al., 2016).

Oğuz (2011) conducted a study in order to determine the effects of computer-based instruction on student achievement. He divided 52 students into two equal sized groups, 26 each,

one as the experimental group that gave each student a computer to use during a unit on "the world, the sun, and the moon," and another group of 26 students who covered the same material sans-computer. While the sample size is very small; one unit of one class, it does give a direct comparison between groups of students covering the exact same material at the same time. Over the course of the study, Oğuz (2011) found that there was a positive impact when students utilized their own device in the classroom compared to a control group, with an average score that was 17.4% higher, a statistically significant amount. Oğuz (2011) also did secondary research to see if other studies had similar results, and found that the positive results of his study were not an outliers; 53 other studies reported positive outcomes in classrooms that utilized 1:1 technology whereas only 5 studies were found that contradicted the findings. While not a magic bullet, there exists a lot of evidence that all the possibilities created by 1:1 technology, as outlined in this paper, does indeed result in tangible improvements to student achievement.

Challenges to Overcome

Though many opportunities for student achievement have been noted, Bebell and Kay (2010) noted obstacles to success. Their study focused on how teaching and learning practices change with the inclusion of 1:1 laptops in the classroom. The study took place over the course of three years in five classrooms, comparing results before and after in order to note the impact of 1:1 technology on shifts in teaching practices, student achievement, student engagement, and enhanced research and collaboration practices. This study is limited to a small scope of students but is very focused over a long period of time. Although their research did discover many positive outcomes of 1:1 technology they also found a number of different issues related the resources and equity that became obstacles. Many other studies made note of these obstacles as well. The following section will examine some of the challenges that could prevent a school

from successfully implementing a 1:1 technology initiative. Through an examination of the obstacles some districts have faced others can learn how to best avoid them.

Teacher Attitudes and Perceptions

A key finding regarding whether or not a 1:1 program works is how the teacher feels about the technology. "Looking across all of the available data, it is clear that teachers nearly always control how and when students access and use technology during the school day" (Bebell & Kay, 2010, p. 18). It takes a massive investment of time and effort for a teacher to successfully implement technology in a way that allows the students to reap its benefits. A teacher unenthusiastic about embracing the change and utilizing 1:1 technology in the classroom is less likely to do so in a manner that boosts student achievement. In a literature review spanning over 70 different sources, Ertmer and Otttenbreit-Leftwich (2010) set out to examine how teachers integrate technology into the classroom; they provided a conclusion that teachers must see devices as useful for learning if they are ever to be implemented in a successful way. This can be a challenge for veteran teachers who already have a routine that has been effective for them over a number of years and may not see the benefit of utilizing 1:1 technology. According to Corn et al. (2011), some teachers resisted the full adoption of the laptops after the initial excitement wore off because they claimed to be completely overwhelmed with having to adjust their traditional way of "doing business" for planning and instruction. This learning curve can be further complicated if the teacher is not familiar with technology. They may even find themselves less knowledgeable about using it than their students.

The importance of teacher attitudes towards technology isn't just for veteran teachers. Incoming teachers, who are considered digital natives, should not automatically be assumed to be pro-technology in the classroom. In a study conducted by Blackley and Walker (2017) two

successive cohorts of students pursuing their bachelor's degree in teaching were studied in order to collect qualitative data from these aspiring teachers in regards to their experience learning about 1:1 technology and if those experiences were positive or negative. The survey benefits from using multiple methods of collecting qualitative information including anonymous surveys, focus groups, and ranking statements on a scale. The study was conducted in the last five years which makes it relevant to modern education practices. The study suffers from a narrow number of participants, only 33 over 2 years, and that it was conducted at only one University in Australia. Blackley and Walker (2017) found that students' beliefs of the use of technology in the classroom was strongly impacted by experience they had in their own training. This means that a student teacher placement in a classroom that doesn't embrace technology or a teacher education program that does not include technology use in its curriculum can set incoming teachers back. Therefore, it should not be assumed that incoming teachers who grew up as digital natives would be willing and proficient users of 1:1 technology and that looking into ways to get buy in and efficacy built into to newcomers in the profession is just as important as it is for veteran teachers (Blackley & Walker, 2017).

Given the importance of getting teachers to buy in to technology use in the classroom, there has been some research on how to help teachers through the process of adopting 1:1 technology. One study, conducted by Tilton and Harnett (2016) set out to do just that by studying the beliefs teachers have about their ability to implement 1:1 technology in the classroom and how various methods impacted that belief over the school year. This study took place in grades 6-8 in a school just starting a 1:1 program with iPad minis, a school with approximately 60 full time teachers working at this school. Each participant participated in three interviews over the course of a year in four-month intervals, which allowed an in-depth exploration over time.

Analyzing the answers over time and cross analyzing the findings with other teachers allowed researchers to draw conclusions from the interviews. One way to help these teachers who do not see 1:1 technology as a useful tool is through colleague modeling. Tilton and Harnett (2016) interviewed a number of teachers at a school adopting iPads and found that when colleagues demonstrated their uses of the iPad it increased enthusiasm among each other. Said one teacher, "I think when we share each other's ideas that's when, because I don't have time to just sit and look at apps and websites so when I hear of something new or see something new I want to try it" (Tilton & Harnett, 2016, p. 84). They also noted that seeing enthusiasm from students in the school can kindle their own enthusiasm, noting a few quotes in particular that demonstrated the point "[The student] was just so excited to show me her video that she made of her drawings" and "If it's done right, it's making our teaching more engaging…more active for the students too" (Tilton & Hartnett, 2016, p. 85).

These findings are verified in another study by Shapley, Sheehan, and Maloney (2010), who set out to study the relationship between how strongly technology in the classrooms was implemented and its impact on students reading and math test scores. To do so, 42 schools with students in grades 6-8 were studied. Twenty-one received technology and 21 served as the control group. The study spanned a four-year period, 600 teachers a year, and a student population of over 2,500 students who were largely economically disadvantaged. The study collected quantitative data through student and teacher surveys and standardized test scores. All this data, taken over the course of four years gives a lot of strength to the findings of the survey. One of the conclusions drawn from the data was that schools that had the full support of technology from all of the teachers in the school, implementation was not only stronger in all the classrooms, but student buy-in to the implementation was also higher.

With so many studies all verifying how important teacher buy-in to the use of 1:1 technology is to its successful implementation it is clear that any school district needs to have a specific plan for getting all staff members on board in order to achieve as much success as possible.

Professional Development

Unfortunately, enthusiasm for 1:1 technology is not the same as competency. Utilization of technology in the classroom requires a pedagogical shift in order to be accomplished successfully. Pegrum et al. (2013) expands on this idea noting that multiple staff members highlighted issues teachers had using technology once it was introduced, such as a lack of preparation, a lack of ideas for meaningful integration, only utilizing the technology in pedagogically limited ways, and, most importantly, that teachers were time-poor, which restricted how much professional development time and personal time they had to do research on appropriate uses and programs that they could use in the classroom in pedagogically effective ways. Corn et al. (2011) verifies this, noting in his study that the schools that had many teachers who reacted negatively to a 1:1 technology initiative were those who taught at schools that did a poor plan for professional development and who taught in schools were only some students had laptops, such as teachers who had to teach a class of juniors and seniors where only the seniors had laptops. This emphasizes just how important strong, ongoing professional development is to the success of a 1:1 laptop program (Corn et al., 2011).

Once teacher buy in is established regarding the importance of devices it becomes very important to ensure teachers have the proper professional development to successfully implement them in the classroom. 1:1 technology isn't a magic bullet that boosts student achievement simply by being in the students' hands. Teachers need to know when and how to

implement 1:1 technology in their classroom which necessitates administrative support and plenty of professional and personal development time given to the subject. Holcomb (2009) notes that when a teacher lacks the confidence in their abilities to utilize devices in a classroom full of students those devices will quickly fall to the wayside.

> The presence of 1:1 laptops does not automatically add value and their high financial costs underscore the need to provide teachers with high-quality professional development to ensure effective teaching. In order to create effective learning environments, teachers need opportunities to learn what instruction and assessment practices, curricular resources, and classroom management skills work best in a 1:1 student to networked laptop classroom setting (Dunleavy et al., 2007, p. 450).

While it is obvious that professional development is key for implementing any type of new initiative, handling a 1:1 initiative requires a more specific plan as teachers have a variety of backgrounds with technology, there is a wide variety of different technology available for school districts to choose to implement, and different classes will have vastly different needs and applications of its tech. Lemke and Martin (as cited in Holcomb, 2009) that found that good professional development shared several qualities; it is embedded in the job, it focuses on student learning and outcomes, it is ongoing over a period of time, and it is reflective. Spires et al. (2009) agrees, adding that countries that have research based on-going teacher education programs, such as Finland and Sweden, show tremendous results in the areas of student results, teacher retainment, and educator empowerment. Furthermore, Spires et al. (2009) suggests that putting teachers through training that mirrors the classroom environment they are expected to create for their students is the most productive way. They should collaborate in groups using the devices to creatively problem solve ways to implement 1:1 technology, developing the very 21st century

skills they are expected to pass along to students. Learning about 1:1 technology implementation cannot be a broad, isolated subject. Rather, in order to be effective the development should be focused on curriculum and standards. Specificity in training will allow teachers to take these new skills directly into the classroom. It's also important that training be an ongoing process so that teachers have an ongoing opportunity to practice, reflect, and revise their practices.

Pegrum et al. (2013) agree, noting that teachers are poor on time and that individualized professional development delivered when teachers need it for a particular lesson is far more effective than formal professional development, which cannot possibly keep up with the rapidly changing field of technology nor all its possible applications in the wide variety of classrooms it is implemented in. This finding is verified by Shapley et al. (2010), who found out over the course of three years that there was a significant relationship between the quality of technology implementation and the quality of professional development the teachers received. The study also found that the classrooms with a high level of immersion had significant correlations with administrative support, collective support for innovative practices, and the overall quality of professional development.

In a study designed to determine how high school classrooms that had implemented a 1:1 technology setting for a number of years have fared. Drayton, Falk, Stroud, Hobbs, and Hammerman (2010) collected quantitative and qualitative data through teacher reports, student surveys, district documentation, interviews with administrative personnel, and multiple classroom observations over the course of three years. The study took place at three different high schools serving over 1,100 students. Drayton et al. (2010) focused on 20 science teachers between the three schools, all of whom already had several years of experience teaching and reported feeling comfortable with technology. The strength of the study comes from focusing on

schools and teachers that already have a lot of experience with 1:1 technology, but suffers from a relatively small sample size. Although Drayton et al. (2010) found many positive impacts of technology implementation in these schools they still found obstacles to successful implementation, notably that there was a lack of time for professional development, especially in the form of teacher collaboration to find and share best practices within the school and department. This isn't just a problem face in American schools. Oriji and Amadi (2016) found that teachers in African countries faced a similar barrier to entry. In a literature review study to determine why teachers can be barriers to implementation and how they can be trained to embrace the technology, Oriji and Amadi (2016) found that teachers were unwilling or slow to implement technology in the classroom if they didn't feel confident in their ability to use it, and in order to feel confident they need time set aside to master these skills. The need for professional development to help drive 1:1 implementation is obvious.

While the importance of professional development is very clear, the fact that studies indicated continuous chances for growth cannot be ignored. However, it can be an immense challenge for budget-strapped school districts and time-strapped teachers to take part in consistent and meaningful professional development. It is therefore necessary to determine what sort of training is most effective. Donovan, Green, and Hansen (2011) set out to do exactly this by studying the type of educational training college students learning to become teachers received. In particular, it was their objective to study their own teaching programs at California State University. One-hundred nine potential teachers entered this program, twenty-eight in a cohort that used 1:1 laptops that were to be integrated into all their work, and the remaining 81 were enrolled in a more traditional cohort that didn't utilize laptops and 1:1 teaching methods. Candidates in both groups took a pre-test upon starting their education and a post-test upon its

conclusion. The test had three main objectives of these tests were to determine the candidates' beliefs in their ability to use and understand technology, estimate how much they currently use technology, and rate their expertise and proficiency with technology. Pre and Post Test findings found that the traditional cohort did not improve in their technology skills or their beliefs as to its usefulness in the classroom whereas the cohort with 24/7 access to a laptop cohort saw growth in those areas. At the conclusion of the study they remarked "We can convincingly say that the experiences provided to our non-laptop candidates are not enough to prepare them for technology-rich K–8 teaching environments" (Donovan et al., 2011, p. 133). The study is strong due to its two cohort design which illuminates the necessity of teachers being given 1:1 instruction in order to be good at utilizing 1:1 technology when they are teachers. However, it is a small sample size and could benefit from being run multiple times. Additionally, the cohorts were self-selecting which might impact how the pre and post test data comes in. Randomized testing might be preferable for more valid data.

While this is not the responsibility of any school district to solve how a University runs its education program, it does present the interesting opportunity of schools forming partnerships with local universities in order to help groom the incoming crop of teachers to their needs. Per Bebell and O'Dwyer (2010), as the popularity of 1:1 programs grows, the quality and depth of preparation that teachers receive for implementation will become a central predictor of program success. With the cost of teacher training so high, both in time and money, schools or large education associations could help ensure their incoming teachers are better prepared by communicating with colleges the importance of training incoming teachers in the use of 1:1 technology.

With the need for good, on-going PD for teachers in 1:1 programs being one of the most vital indicators of success, it is important that these initiatives secure funding for that very purpose. Unfortunately, it does not appear as if that is the case. Richardson et al. (2013) conducted a large-scale analysis of large initiative 1:1 programs by compiling all the data in an Access Database. In this case they narrowed it down to initiatives that provided students a device stronger than a cell phone, and did not include programs that had students bring their own device. They also limited the scope to initiatives that were regional, state-wide, or nation-wide, ignoring local or district level implementations. They then collected data on these initiatives across all 193-member countries of the United Nations for analysis. The study benefits from the large scope and the analytic processing power of the Access database program, but does not include a lot of observations that could have been made by including smaller-scale initiatives. Furthermore, the availability of details on the initiative varied from country to country. One of findings in Richardson et al. (2013) was that while the rollouts for these initiatives often included funding for training at the outset of the program, there did not seem to be any plan for continuous training planned in most of the studies. This contrasts with much research that indicates that an initial training period is simply not enough to give teachers the training to properly utilize devices in the classroom.

Not a Replacement for Good Pedagogy

In their study on the efficacy of mobile devices, Pegrum et al. (2013) noted that both school administrators and teachers reached the conclusion that devices themselves are simply not enough, it is how they are to support teaching and learning that matters. This real-world finding verified the conclusion of educational theorists who studied mobile learning. Blackley and Walker (2017) agrees, noting that having a mobile device in each student's hand does not ensure

good digital pedagogy. Adds Spires et al. (2009) "Obviously, the addition of technology ubiquity within the classroom does not in and of itself add value. Value is added depending on ways the technology ubiquity is applied in the overall design for learning" (p. 235). A 21st century classroom full of students completing math work on their iPads can function remarkably similar to a classroom of student's centuries older working with the tools of their time. A math class that only uses their iPads as a calculator looks no different than a classroom 20 years ago where each student brought their own calculator. Without teacher buy-in the devices just become a thrilling an expensive gimmick.

A school can overcome many of the problems listed above and still not effectively implement a 1:1 program. Even if teachers are interested in and have time to train, even if systematic supports are built in by administration to help teachers minimize distractions and offer good IT support, a 1:1 program can still lack efficacy if teachers' pedagogical practices in the classroom don't adjust to best make use of the technology. Blackley and Walker (2017) note that classrooms which use traditional classroom practices alongside a sea of open laptops are the worst-case scenario of 1:1 implementation and that the technology is being used as a substitute tool to traditional classroom tools such as pencils and papers and bringing about no functional change. Blackley and Walker (2017) argue that in order for classrooms to take advantage of digital classrooms to transform teaching in the classroom teachers need to move away from relying on the substitution and augmentation strategies and work towards incorporating more modification and redefinition.

In a series of studies cited by Romrell et al. (2014), the full efficacy of a redefinition was explored. They provided examples of projects that had students replying to texts in order to simulate the management of a flood disaster as well as a project where students were able to

diagnose patients and receive live feedback from an app as they worked. These assignments would not be possible without technology, and in each instance the use of technology able to provide instant feedback, a personalized experience, and access to relevant information as it became necessary. In a review of other studies they found that every project in the redefinition category was personalized, situated and connected, and therefore had the potential to transform the way students learned. However, they did find a caveat to these findings, noting that when the 1:1 device is mobile in nature the ability to engage with assignments via that device as well as the ability to access it at times and places more convenient to the student increased student learning, even if the use of the device did not result in any functional improvement of the assignment. Keeping these three factors in mind is the surest way to ensure educators get the most out of technology in the classroom.

Students' Pre-existing Technological Competence

Per the study by Cavanaugh et al. (2011) on the impact of 1:1 technology on student achievement, it is not merely enough to learn with technology, but students need to learn how to learn with technology. Students who are new to using technology need to be made comfortable with the capabilities of the devices, while those who are more familiar with using devices outside of the school setting need guidelines and information about how to utilize their computers appropriately and productively.

Despite popular assumptions that today's students have grown up with computers and are therefore competent in their use, often this is not the case. Grundmeyer (2013) set out to determine the perceptions of first-year college students who spent at least two years in a 1:1 technology environment in high school regarding whether or not those studies prepared them for college. Interviewing 15 students on these topics revealed the details of these students'

experiences, although the small number of students and lack of data tied to achievement does limit the extent of the findings. Grundmeyer (2013) found that although many students spend hours a day utilizing technology for the purposes of instant messaging, listening to music, watching television, sharing media, browsing the web and playing games these uses should not be misconstrued as expertise. Students need time in school in order to learn '21st century skills' such as critical thinking, creativity, complex communication skills, sociability skills and employability skills, as they are not gained by a typical students' unstructured use of technology. As is the case for any number of academic abilities, students come to school with a wide range of technological skills and experiences. Students who enter a 1:1 classroom without the proper technology skills can face negative consequences to their learning. Cavanaugh et al. (2011) found that students without the proper skill set suffered negative effects such as a decrease in writing scores and a high level of frustration in the technology. In each of these cases of decreased scores it was found that it resulted from students inexperienced with technology who were trying to learn how to use the device in conjunction with the course material and did not fully learn the material as a result.

Romrell et al. (2014) touch on this in a literature review of the SAMR model, which aims to increase the pedagogical rigor of teachers' implementation of 1:1 technology through the review of m-learning studies conducted by twenty-six different researchers. While the researching the SAMR model itself they also looked into obstacles that are faced by teachers implementing any form of 1:1 technology. They found that there are some strategies a teacher can use to help their students get up to speed with technology they are not familiar with. For instance, it is important that students are incentivized to want to engage with the technology. Making use of the technology as part of the final grade can be one such way of accomplishing

this. Their findings suggest that 1:1 technology activities should be included in graded assignments and assessments so that students are encouraged to familiarize themselves with the devices, thus gaining more confidence and expertise as the school year progresses. Without these incentives students who are not comfortable on the devices have less incentive to learn to do so.

Minimizing Distractions

For as long as there have been students in classrooms, there have been sources of distraction. From passing notes to personal cellphones, 1:1 technology is another source of distraction that teachers must manage in the classroom in order to achieve student success. In instances where 1:1 initiatives failed, distraction was cited as a cause. Holcomb (2013) mentions that in schools where 1:1 programs were not as successful, teachers viewed the laptops as a source of distraction and that furthermore parents were fed up with their distraction and misuse both in school and at home.

In an attempt to better understand how to keep students focused in a 1:1 classroom, Tagsold (2013) spent time observing in a school with a robust 1:1 program including strong professional development in order to best address this issue. The study collected qualitative data from eight classroom observations, interviews with 16 students and 4 teachers in traditional and advanced English classes over the course of a school year. Tagsold (2013) found that while students and teachers openly admitted that the devices and the internet in particular were a constant source of distraction, that there were some tried and true methods which helped students avoid this distraction. The most successful methods used included a focus on creating engaging assignments that students wanted to do, allowing technology to make lessons more hands on, having set times, such as during lectures, where the devices were to be put away, giving students as many opportunities as possible to personalize their lessons, the teacher walking about the

room in order to monitor students from all angles, allowing students to collaborate, setting deadlines and making them visible online, having students submit assignments to an online drop box, and quickly posting grades online so students can stay up to date with their grade in the class. The study's strengths include how thorough the insights into the classroom were and which specific techniques were helpful, although the study could be stronger by doing the same procedure in other schools to see if it is consistent across more settings.

In a series of interviews with Grundmeyer (2013), many students agreed that 1:1 devices were a source of distraction but went on to cite some techniques the school implemented in order to combat this including firewalls that blocked websites the schools chose and computer programs that could monitor devices by the teacher in the room and other staff members throughout the school. This program gave authority figures the ability to monitor distracted students as well as the ability to block them and inform teachers of inappropriate use. This ties in with the idea that implementing proper systematic support is crucial for the success of a 1:1 program.

Systematic Support

The results from a study by Bebell and Kay (2010) show that the technology issues go beyond the actual devices in the students' hands. Even in classrooms with full 1:1 technology integration a lack of resources such as projectors, printers, chargers, and other resources in one classroom compared to another resulted in a disparity in the experience. Having supporting technology is necessary for the full 1:1 experience.

Another troubling obstacle is device repairs. Devices that have been in use for three or more years start to become outdated and are more susceptible to damage that can impact the functionality of the device. In an interview with Grundmeyer (2013), a student stated, "Many

students were frustrated with repairs during the third year with the laptops. It sucked when a computer was slow and they couldn't be fixed or repaired. Tech staff often seemed to be more concerned with new features than repairing old machines for students" (p. 212). Considering the financial burden of continually buying new devices it seems prudent for schools to have a system in place to ensure devices can be repaired and remain effective for student use in the classroom as long as possible.

Measuring Benefits

Promising results that indicate 1:1 programs can help students increase test scores as demonstrated by standardized test scores between the 1:1 group and a control group. While this is very important to take into consideration when evaluating the implementation of a program, Holcomb (2009) notes that many of the touted benefits of 1:1 technology initiatives such as increased workforce relevant skills are difficult to measure and do not align with any current standardized tests. This makes it difficult to assess all the supposed benefits of a 1:1 computer program. While many agree that the learning environments afforded by 1:1 programs are very rich, it can be hard to consider and quantify the benefits, especially in the short term. Even teachers and principals who enjoy the 1:1 technology programs in their own classrooms and districts admit that it is hard to quantify positive results, and it may take years to do so (Bebell & Kay, 2010).

Findings by Corn et al. (2011) concur, with teachers reporting that their students are learning more after a 1:1 laptop program was implemented, but that isn't necessarily going to be reflected on test scores. Said one administrator "We have kids using [Windows] Movie Maker to put their ideas together that summarize a story, that doesn't translate necessarily into test scores, right? And unfortunately that's how we're measured" (Corn et al., 2011, p. 17-18). This doesn't

negate the positive aspects of increased test scores but for districts that want to see evidence of the reported benefits of a 1:1 program the lack of evidence in some areas is an obstacle to implementation.

Choosing the Right Device

A further complication in implementing a 1:1 technology program is the high cost of doing so. Many school systems have a limited budget and are answerable to the community who want to ensure the money is being spent efficiently for their children's benefit. Not only are schools left to determine whether or not 1:1 are beneficial or not, but also whether this is the appropriate outlet for limited funds or if there are other alternatives. In their study, Crook et al., (2014) argued that due to the fact that most students had computers at home and all had at least some level of access at school, a higher price-tag would not be cost-effective for schools, especially because the on-going costs of these programs are not always well accounted for at the beginning (Richardson et al., 2013).

The world of technology is a large, competitive, and constantly changing one. School districts have a wide variety of choices when it comes to how they implement a 1:1 program. Tablets, laptops, Chromebooks, hybrid devices, computer labs with traditional desktops are all options, and each of those categories has many different options to pick from. Fortunately for school districts, Pegrum et al. (2013) found that the principals, vice principals and teachers they interviewed concurred with educational theorists that the specific devices are less important that how they are utilized and supported in the classroom. When it comes to all the decisions that school administrators need to make when implementing a 1:1 program this one has less impact than many others discussed in this thesis.

Chapter III: Discussion and Conclusion

Summary of Literature

For schools looking to implement a 1:1 technology initiative, it is clear that there is potential for a boost in many of the factors that lead to increased student achievement. First, many researchers note that there is an increase in student buy-in when devices are present in the classroom. Some teachers note that simply the announcement that 1:1 technology is going to be used in a lesson gets the students excited (Pegrum et al., 2013) and many teachers see an increase in positive learning behaviors, including motivation (Cavanaugh et al., 2011). It is a consistent observation made by researcher that, regardless of other variables, 1:1 technology programs increased student engagement in the classroom (Debell et al., 2010; Russell et al., 2014). Not only is this behavior beneficial for learning in the classroom, but 1:1 technology programs have been shown to keep students in the classroom as well with focus group studies showing a wide disparity in attendance and discipline rates between classrooms that have 1:1 technology and classrooms that do not (Rosen et al., 2012). Even if 1:1 technology didn't have any other pedagogical uses, the simple fact that they increase the amount of time students spend in class is a significant reason for a school district to consider implementing them.

Meaningful gains in achievement, engagement, discipline rates and attendance rates are fantastic outcomes of a 1:1 technology program, but they don't come about by just by having the devices in hand. Rather, 1:1 technology in the classroom must be implemented in pedagogically meaningful ways in order for students to benefit from them (Blackley et al., 2017; Pegrum et al., 2013). The biggest benefit of these devices to pedagogy in the classroom is that it gives teachers the tools to change their teaching style from being teacher centric to student centric. It is widely agreed that it gives students the chance to engage with their learning higher on the ladder of

Blooms Taxonomy (Howard & Rennie, 2013; Rosen et al., 2012). It was found that upon the introduction of 1:1 technology, students became more active and interested in their learning (Holcomb, 2009; Rosen et al., 2012; Pegrum et al., 2013), initiated significantly more conversations with their teachers (Corn et al., 2011; Rau et al., 2008; Rosen et al., 2012; Spires et al., 2009) and also collaborate with their peers more frequently (Corn et al., 2011). All of these practices boosted the amount of time students spent thinking about their thinking, allowed them to work on more extension activities if they got their normal work done first (Corn et al., 2011), and boosted student achievement (Serin, 2011). Throughout the review of the research an increase in student motivation and engagement was very commonly cited as one of the benefits of bringing 1:1 technology into the classroom. This is one aspect of the research that is fairly conclusive; students respond to technology in the classroom.

One way of boosting pedagogy through student centered practices with the use of 1:1 technology is through formative assessment. 1:1 devices in the classroom has been shown to increase the frequency of and speed of formative assessments, giving teachers real-time feedback on what their class does and doesn't understand (Dunleavy et al., 2007). They also enable many formative checks that would not be possible in a classroom without technology, such as instant response programs, finding media that shows understanding of a concept, providing instant feedback between students and teachers, live polling, exit tickets, and more (Dunleavy et al., 2007; Ward et al., 2016). This increase in formative assessment allows students to actively engage in their own learning and constantly check their understanding, which makes the classroom setting far more student centered than traditional classrooms.

Another student-centered practice boosted by 1:1 technology is how the devices allow schools to create flexible learning spaces for students. With so many 1:1 programs turning to

mobile-devices, the classroom no longer needs to be setup in traditional desks and rows and students can move around the room, forming and re-forming groups to work collaboratively with. Additionally, the mobility of these devices allows students to take them home with them and access high quality, engaging content wherever and whenever they'd like (Holcomb, 2009; Pegrum et al., 2013). This type of mobility and flexibility enables teachers to make use of Flipped Classroom teaching strategies, which have been shown to have positive impacts on student outcomes due to students being able to access information at their own pace as many times as necessary in order to master the material (Jakobsen & Knutsen, 2017).

1:1 technology has also shown to have some impact on disadvantaged students, both positive and negative. Students with learning disabilities, physical impairments that would affect them in the classroom, and English Language Learners, who might struggle compared to able-bodied students who speak English as their first language in a traditional classroom setting have shown that the use of 1:1 technology helps to close the learning gap between these groups of students (Pegrum, 2013; Taj et al., 2016; Zucker & Hug, 2007).

While learning about these methods of student centered learning that 1:1 technology makes possible is useful for teachers in the classroom, it is important to determine if the utilization of the devices results in positive student outcomes. While it is suggested the inclusion of 1:1 technology helps develop students 21st century skills to help prepare for the workhorse (Corn et al., 2011), there is little quantifiable data on how much of an effect this has on students in school and later in their careers. Therefore, the metric most often tracked to determine the success of 1:1 technology initiatives is how students perform on tests and in the gradebook. Most studies did show positive results from the inclusion of 1:1 technology. The positive gains were spread out through many different subjects including science (Crook et al., 2014; Oğuz, 2011),

ELA (Bebell & O'Dwyer, 2010; Holcomb, 2009; Rosen et al., 2012), Math (Holcomb, 2009; Rosen et al., 2012), and overall GPA increases (Holcomb, 2009). While there were a few studies that found some 1:1 programs to be ineffective (Harris et al., 2016; Holcomb, 2009), the majority of studies indicated positive results (Oğuz, 2011).

Standing in the way of all this potential student achievement are the numerous hurdles that must be overcome to rollout a 1:1 technology initiative. These concerns can be grouped into three different categories; challenges for the teacher, challenges for the students, and challenges for administration.

For teachers, a source of difficulty in implementing 1:1 technology is that they do not have the inherent skills to utilize technology nor the interest in learning (Bebell & Kay, 2010; Ertmer & Otttenbreit-Leftwich, 2010). While veteran teachers who are set in their routine are particularly vulnerable to this lack of interest due to already being set in their routine (Corn et al., 2011; Ertmer & Otttenbreit-Leftwich, 2010), many incoming teachers are no different (Blackey & Walker, 2017). It was found that a meaningful way of overcoming this was to create an environment where teachers shared techniques with each other, creating that enthusiasm through sharing and observing best practices, and that this type of comradery and enthusiasm was a strong predictor in implementing 1:1 technology as well as achieving student buy-in (Shapley et al., 2010; Tilton & Harnett, 2016). Equally as important is devoting time to professional development to help teachers learn the skills and methods to utilize 1:1 technology, because teachers do not typically have the time to devote to learning these skills on their own (Pegrum et al., 2013; Corn, 2011; Holcomb, 2009; Shapley et al., 2010; Drayton et al., 2010; Oriji & Amadi, 2016). While continuous on the job training is widely agreed upon as being incredibly important (Spires et al, 2009; Corn et al, 2011; Pegrum et al., 2013) it is also noted that there is an

opportunity for incoming teachers learning these skills from the very beginning of their careers if the University they attend both emphasizes the importance and gives teachers practical hands-on experience learning with 1:1 technology themselves (Bebell & O'Dwyer, 2010; Donovan et al., 2011). All this training is extremely vital, as it has been shown that using the devices without proper implementation doesn't result in any academic gains for students (Blackley & Walker, 2017; Pegrum et al., 2013; Spires et al., 2009), highlighting the fact that while the devices can be very effective tools, they still must be implemented in intentional ways to are grounded in sound pedagogical practices. However, these findings are troubling when considering that 1:1 rollouts typically only account for PD at the beginning without considering a plan, or budget, for ongoing PD (Richardson et al., 2013; Spires et al., 2009). This is expanded on by the SAMR model. At their lowest level of functionality, 1:1 technology in the classroom is just a substitute for more traditional mediums of learning; instead of getting a lecture from a teacher you get one from a YouTube video, instead of completing an assignment on paper and turning it into a basket you complete and turn it in digitally. While this can add a level of convenience and accessibility that can be beneficial to students, it does not truly transform learning in the classroom like giving students the tools to showcase their learning by creating things using the wide array of technological tools 1:1 technology can provide (Blackey & Walker, 2017; Romrell et al., 2014).

Students also face obstacles when it comes to adopting 1:1 technology into the classroom. One of the largest hurdles for them is ensuring that they have the proper technological knowledge and skill to utilize the devices in a manner that is productive towards their education. Despite popular beliefs, today's youth are not automatically technology savants and unstructured use of mobile technology for the purposes of education does little to prepare students for effective use of technology in the classroom (Grundmeyer, 2013). For students who do not have

exposure and training with these devices prior to their integration into the classroom it can transform every lesson into two different lessons; the intended assignment for the course as well as learning how to manipulate a device that they are not fully familiar with. These students who are struggling to master the use of their device do not show the same amount of academic gains as their peers with more competence do (Cavanaugh et al. 2011; Grundmeyer 2013). This process of familiarization can be accomplished by teachers taking time to model the technology (Grundmeyer, 2013) and utilizing it consistently with assignments throughout the year so that students have incentive to continue to utilize and improve their skills (Romrell et al., 2011).

A common criticism for the inclusion of 1:1 devices is that they are a very tempting source of distraction for students. Research is quick to verify this, teachers, parents, and students alike all have made comments about the distractions 1:1 devices can be (Grundmeyer, 2013; Holcomb, 2013; & Tagsold, 2013), and that when more instances of these frustrations were reported the success of a 1:1 program was less (Holcomb, 2013). While some solutions included software that teachers and administration can use to monitor device use and block certain websites and apps (Grundmeyer, 2013), many of the successful strategies for diminishing student distraction in a 1:1 technology are the same strategies that define good pedagogy; engaging lessons, chances to be creative, student choice, student worktime and collaboration, and a teacher who is present and aware of the room. In other words, ensuring students are not distracted by 1:1 technology is no different than ensuring they aren't distracted by any other means, a major concern of teachers from any era.

The last leg of a successful 1:1 technology program is administrative support. To ensure a successful rollout administration needs to make sure that a proper infrastructure exists in the school to support 1:1 technology. This includes having enough equipment to ensure the

computers are being used to their full capacity such as printers, chargers, and projectors (Bebell and Kay, 2010), ensuring the devices and internet network are properly maintained and are fast enough for use in the classroom (Grundmeyer, 2013).

Administrators also have to struggle to justify the immense cost of using 1:1 technology despite the fact that many benefits are hard to measure. An increase in workforce relevant skills and creative problem solving is not something that translates onto the increasingly frequent standardized tests (Holcomb, 2009; Corn et al., 2011; Bebell and Kay, 2010) and yet those are the areas that many teachers and principals are noticing that their students are achieving gains. The need to measure results is important because the cost of implementing these initiatives are extremely high and some argue that with so many students having access to technology at home that the cost-benefit is very low (Crook et al, 2014). However, one thing that administrators do not have to worry about is which device is the best device for student achievement, as there has been consensus showing any form of technology, be it phones, tablets, laptops, or hybrid devices being superior or inferior to another.

Limitations

To locate studies for this thesis, searches of ERIC and Google Scholar were conducted focusing on peer reviewed studies published from 2007-2017. This ten year span was chosen as to ensure that the studies focused on modern technological environments. The majority of the studies came from peer-reviewed journals that focus on how technology can be utilized for the purposes of enhancing pedagogy. The key words that were used in these searches included “1:1 technology,” “one to one technology,” “m-learning,” “mobile-learning,” “technology in the classroom,” “technology and student achievement,” and “1:1 technology on student

achievement." Some searches were made that included additional key terms of interest including 'Professional Development', 'Student Achievement' and 'Student Motivation'.

Implications for Future Research

Future research should start to get more detailed into the specifics of how to implement a 1:1 technology program. There have been many studies on whether or not they can be effective, and the general consensus is that they can, if implemented correctly. It would seem redundant to do a study with that guiding question again. Rather, studies should narrow their focus to discern optimal strategies for training staff, developing new curriculum, familiarizing students, determining the areas 1:1 technology can be most effectively implemented, building in administrative and technical support, and more. Simply put, studies should not focus on if 1:1 technology should be implemented, but how.

Another area of research that needs to be explored further now that 1:1 technology has become more common place is a look at long term results of students who go through these programs. One of the benefits of these programs that is frequently mentioned is that they give students experience with technology that they will need to use in the workforce. While such a study would be much harder, more time consuming, and more difficult to run, these results, in my opinion, would go further to shed light into the full impact, or lack thereof, of 1:1 technology programs.

Implications for Professional Application

The literature on 1:1 technology programs in the classroom should lead teachers in a direction where they are not only open to 1:1 technology in the classroom, but that they are thoughtful and intentional in designing lessons that incorporate the technology in a pedagogically meaningful manner.

Teachers resistant to the technology need to open their mind to the idea that research shows the devices can boost student achievement as well as make classes more student centered and the students in it more responsible for their learning. Teachers who have embraced it already need to examine their own teaching methods and ask themselves if what the manner they use it is merely at the replacement level or if it is transforming the way that students are learning in their class. While there is nothing wrong with replacement level uses for technology, if that is the only way the technology is being implemented than the teacher is doing themselves and their students a disservice by not using these powerful devices to their full potential.

Specific areas of pedagogy that 1:1 programs have shown to be a boon towards include student engagement, giving students the ability to direct their own learning rather than learning everything from the teacher, finding new ways for students to communicate with one another and the teacher, utilizing 1:1 technology for quick and detailed formative assessments, allowing students more flexibility with where and when they are engaging with classroom materials, giving more opportunities to disadvantaged students and those with disabilities, and allowing students to develop important 21st century workforce skills such as creativity and collaboration. Teachers in 1:1 programs should self-reflect on their practices to see which of these areas they are already using the devices to enhance their teaching, and which ones they could work on adding to their toolkit.

As for administrators, the most important takeaway is the importance of constructive and ongoing professional development for teachers. Of all the literature examined, this point was the one that came up most frequently and was unanimously supported by all researchers; teaching teachers how to teach in a 1:1 technology environment is the most important aspect of a successful 1:1 implementation. It shouldn't be expected that time-poor teachers should learn how

to do this on their own in their own time. Good 1:1 technology professional development should model how a classroom with 1:1 devices is run; teachers should be able to collaborate, problem solve, and share best practices with one another. Utilizing the devices and engaging in the pedagogical practices in this training will give teachers the skills, inspiration, and confidence to do it in their own classrooms. This training helps reluctant teachers buy-in to the idea of a 1:1 technology program, and gives them the ability to use the devices in pedagogically constructive ways.

All educators should know that these devices can indeed boost student achievement as well as give them intangible skills that are sought by employers. But the initial cost of purchasing the devices is where things start, not end. A total commitment to the program, the training teachers and students in their use is absolutely necessary for a successful 1:1 technology implementation.

Conclusion

It is clear that 1:1 technology classrooms can boost student achievement through transformational pedagogical practices that allow classrooms to be more student centered. However, 1:1 technology is not a magic bullet, and without a plan to train and support teachers in constructive uses a school district is merely left with an expensive device that does not add to the classroom meaningfully, and in fact may be a distraction. Schools should be intentional and deliberate in their planning when looking to make an investment in a 1:1 technology program.

References

Bebell, D., & O'Dwyer, L. M. (2010, January). Educational outcomes and tesearch from 1:1 Computing Settings. *The Journal of Technology, Learning, and Assessment, 9*(1). Retrieved July 2, 2016, from www.jtla.org.

Bebell, D., & Kay, L. (2010). One to one computing: A summary of the quantitative results from the berkshire wireless learning initiative. *The Journal of Technology, Learning, and Assessment* 9.2 (2010): n. pag. Web. 6 July 2016.

Blackley, S., & Walker, R. (2017). Pre-service teachers' reflections: The influence of school 1:1 laptop programs on their developing teaching practice. *Australian Journal of Teacher Education, 422*, 1-13. doi:10.14221/ajte.2017v42n2.1

Cavanaugh, C., Dawson., K., & Ritzhaupt, A. (2011). An evaluation of the conditions, processes, and consequences of laptop computing in K-12 classrooms. *Journal of Educational Computing Research* 45.3

Corn, J. O., Tagsold, J. T., & Patel, R. K. (2011). The tech-savvy teacher: Instruction in a 1:1 learning environment. *Journal of Educational Research and Practice, 1*(1), 1-22. Retrieved June 21, 2017, from http://files.eric.ed.gov/fulltext/EJ1118465.pdf

Crook, S. J., Sharma, M. D., & Wilson, R. (2014). An evaluation of the impact of 1:1 laptops on student attainment in senior high school sciences. *International Journal of Science Education*, 37(2), 272-293. doi:10.1080/09500693.2014.982229

Donovan, L., Green, T., & Hansen, L. E. (2011). One-to-one laptop teacher education. *Journal of Research on Technology in Education, 44*(2), 121-139. doi:10.1080/15391523.2011.10782582

Drayton, B., Falk, J. K., Stroud, R., Hobbs, K., & Hammerman, J. (2010). After installation ubiquitous computing and high school science in three experienced, high technology schools. *The Journal of Technology, Learning and Assessment, 9*(3). Retrieved from file:///C:/Users/jared_000/Downloads/1608-1745-1-PB.pdf.

Dunleavy, M., Dexter, S., & Heinecke, W. (2007). What added value does a 1:1 student to laptop ratio bring to technology-supported teaching and learning? *Journal of Computer Assisted Learning*, *23*(5), 440-452. doi:10.1111/j.1365-2729.2007.00227.x

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3), 255-284. Retrieved June 21, 2017, from http://files.eric.ed.gov/fulltext/EJ882506.pdf

Gerber, L. N., & Ward, D. D. (2016). Classrooms for the millennials: An approach for the next generation. *NADE Digest, 9*(1), 23-26. Retrieved from https://eric.ed.gov/?id=EJ1097454.

Grundmeyer, T. (2013). Adopting technology: Using student qualitative data and Gartner's hype cycle. *Journal of Education and Training Studies, 2*(1), 207-216. doi:10.11114/jets.v2i1.228

Harris, J. L., Al-Bataineh, M. T., & Al-Bataineh, A. (2016). One to one technology and its effect on student academic achievement and motivation. *Contemporary educational technology, 7*(4), 368-381. Retrieved June 21, 2017, from http://files.eric.ed.gov/fulltext/EJ1117604.pdf

Holcomb, L. (2009). Results & lessons learned from 1:1 laptop initiatives: A collective review. *TechTrends* 53.6: 49-55.

Howard, S. K., & Rennie, E. (2013). Free for all: A case study examining implementation factors of one-to-one device programs. *Computers in the Schools*, 30(4), 359-377. doi:10.1080/07380569.2013.847316

Jakobsen, K. V., & Knetemann, M. (2017). Putting structure to flipped classrooms using team-based learning. *International Journal of Teaching and Learning in Higher Education, 29*(1), 177-185. Retrieved July 6, 2017, from https://eric.ed.gov/?q=Putting Structure to Flipped Classrooms Using Team-Based Learning&id=EJ1135820.

Lane, K. E., Lemoine, P., Tinney, T. M., & Richardson, M. D. (2014). Modify and adapt: Global higher education in a changing economy. *International Journal of Innovation in the Digital Economy, 5*(2), 24-36. doi:10.4018/ijide.2014040103

Russell, M., Bebell, D., & Higgins, K. (2004). Laptop learning: A comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent 1:1 laptops. *Journal of Educational Computing Research* 30.4

Oriji, A., & Amadi, R. (2016). E-education: Changing the mindsets of resistant and saboteur teachers. *Journal of Education and Practice, 7*(16), 122-126. Retrieved July 6, 2017, from https://eric.ed.gov/?q=E-education%3a Changing the Mindsets of Resistant and Saboteur Teachers&id=EJ1108660.

Pegrum, M., Oakley, G., & Faulkner, R. (2013). Schools going mobile: A study of the adoption of mobile handheld technologies in western Australian independent schools. *AJET Australasian Journal of Educational Technology* 29.1

Rau, P. P., Gao, Q., & Wu, L. (2008). Using mobile communication technology in high school education: Motivation, pressure, and learning performance. *Computers & Education, 50*(1), 1-22. doi:10.1016/j.compedu.2006.03.008

Richardson, J. W., McLeod, S., Flora, K., Sauers, N. J., Kannan, S., & Sincar, M. (2013). Large-scale 1:1 computing initiatives: An open access database. *International Journal of Education and Development using Information and Communication Technology, 9*(1), 4-18. Retrieved June 21, 2017, from http://files.eric.ed.gov/fulltext/EJ1071344.pdf

Romrell, D., Kidder, L. C., & Wood, E. (2014). The SAMR Model as a framework for evaluating mLearning. *Online Learning, 18*(2), 1-15. doi:10.24059/olj.v18i2.435

Rosen, Y., & Beck-Hill, D. (2012). Intertwining digital content and a one-to-one laptop environment in teaching and learning. *Journal of Research on Technology in Education*

Serin, O. (2011) The effects of the computer-based instruction on the achievement and problem solving skills of the science and technology students. *TOJET: The Turkish Online Journal of Educational Technology*

Shapley, K. S., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2010). Evaluating the implementation fidelity of technology immersion and its relationship with student achievement. *The Journal of Technology, Learning and Assessment,9*(4). Retrieved June 20, 2017, from https://ejournals.bc.edu/ojs/index.php/jtla/article/viewFile/1609/1460.

Spires, H., Wiebe, E., Young, C., Hollerbrands, K., & Lee, J. (2009). Toward a new learning ecology: Professional development for teachers in 1:1 learning environments (1st ed.). Retrieved from *http://www.unc.edu/world/toward-a-new-learning-ecology(12).pdf*

Tagsold, J. T. (2013). Why aren't they paying attention to me? Strategies for preventing distraction in a 1:1 learning environment. *The Journal of Research in Education, 2*(Fall). Retrieved June 20, 2017, from http://files.eric.ed.gov/fulltext/EJ1098416.pdf

Taj, I. H., Sulan, N. B., Sipra, M. A., & Ahmad, W. (2016). Impact of mobile assisted language learning (MALL) on EFL: A meta-analysis. *Advances in Language and Literary Studies, 7*(2). doi:10.7575/aiac.alls.v.7n.2p.76

Tilton, J., & Hartnett, M. (2016). What are the Influences on teacher mobile technology self-efficacy in secondary school classrooms? *Journal of Open, Flexible and Distance Learning, 20*(2), 79-93. Retrieved June 21, 2017, from http://files.eric.ed.gov/fulltext/EJ1120881.pdf

Zucker, A., & Hug, S. (2007). A study of the 1:1 laptop program at the Denver School of Science & Technology. *Denver School of Science and Technology*: n. pag.