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Using 1:1 Computing Devices in a Classroom Setting

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by

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Chapter 1: Introduction

Recently I had returned to teaching after 8 years away from the profession, and in my time away a technological revolution had been ushered in with the arrival of the iPad and the apparent need for every student to have their own computing device. Computer technology is an ever more vital part of our lives and education. School districts are investing millions upon millions of dollars for the end goal of having a device, an iPad, or laptop assigned to every student for their own use.

During the past 3 years, I have found myself with the opportunity to explore the possibilities of these new technologies in the classroom in three widely varying scenarios. I did find them to be invaluable tools, their uses ranging from imaginative, engaging student learning activities to simply making organization easier. I am, by my own nature, attracted by the possibilities and promise in this new technology. I also found many colleagues who have abhorred the introduction of 1:1 devices in the classroom. One opinion is that they simply saw them as toys and that there was little to no reason to have them for teaching. That attitude was observed in varying degrees during discussions about device use and presentations about technology plans as they moved forward.

Why is there such divisiveness? Why would some in the education world meet technology with such skepticism? One reason is that the research just is not there yet, and the findings are a constantly moving target. My own daughter, who at the time of this writing is an elementary student that has just been issued a device of her own, is older than the first iPads. The technology is still in its infancy. Another is the wide disparity with which the technology is implemented. Selwyn, Nemorin, Bulfin, and Johnson (2017) described a veritable hodge-podge

of deployments in their study, the worst case being a “Bring Your Own Device” (BYOD) program where teachers cannot be sure of what technology their students will have and the best being programs where the school provides the same device across the board, or there’s a lack of training for teachers, or teachers just feel they get in the way of teaching.

> Useful and welcome as the convenience and utility of these technologies are in educational activities within school, we have not come across much evidence of their having transformed educational practices for the better, nor of their having enabled innovative approaches to teaching and learning which would not otherwise have been possible, nor—most importantly—do they appear to have been used in order to expand the scope and quality of students’ understanding of the world. (Blikstad-Balas & Davies, 2017, p. 329)

School districts push on, and I feel this is rightly so. We just need a better understanding of this technology that has moved way too fast for us to adapt to it. At the time of this writing, in one school district that I had observed, there is a perfect storm of circumstances in that there is a new reading curriculum being implemented across all elementary grades along with a extending the middle and high school one-to-one technology initiative all the way down to the Kindergarten level. Teachers are getting training on the new curriculum, and the district will be closely watching to make sure that it is rolled out properly. Alongside that are classes that have an iPad for every student. With the relative newness of these devices and the limited research that has been conducted, it seems timely to examine them in the field.

Research Questions

My primary research question is: Has the addition of 1:1 devices into an educational environment had a positive effect on the academic performance of students?

Additional questions include:

- Is there a method of implementing 1:1 devices into an educational environment that is better than others?
- Has the introduction of 1:1 devices into an educational environment changed the way teachers are teaching?

Focus of Paper

The research studies reviewed in Chapter 2 were published primarily in the United States between the years 2012 and 2019, as the technologies studied were not widely in use until the year 2010. Action research participants included students in grades four through six at three different schools (one private, two public) using iPads, Chromebooks, and Android-based tablets. The LibSearch at St. Cloud State University was the primary search engine used for research, which is run and supported by the Minnesota Program for Automated Library Systems and provides access to academic databases.

I critically reviewed research papers, primarily using the following keywords: *tablet, tablet computer, iPad, Chromebook, laptop, classroom, education, elementary,* and *school*. Chapter 1 includes background on the study of one-to-one devices in the classroom, previous research, and definitions of importance for the topic. Chapter 2 reviews current research literature to examine the use and effectiveness of this new technology as it is being introduced. Chapter 3 examines my own observations while working in the field at three different schools

with three different implementations of the technology and then discusses conclusions, recommendations, and the implication of the research reviewed in Chapter 2.

Importance of the Topic

The most recent revolution in the classroom has been the introduction of a computing device for each student to use. While computers have been in schools for decades, the restrictions of cost and size have relegated them to dedicated rooms in our schools, and students have only had access to them at scheduled times. Assigning a portable computing device to every student in a school setting has opened up the use of computing technology to become an everyday occurrence, not just an occasionally scheduled learning experience. On top of that, it has turned the use of computers in educational settings to be more personal and more individualized.

But with the relative newness of the technologies and methodologies, there is still much work to be done to determine what are the best practices or whether or not the impact on education even makes it worth it to take on the additional work of implementing one-to-one computing devices in a classroom at all. As with any new trend in education, it is far too easy to jump in without fully understanding the why and how of implementation. As an educator in the field who is responsible for implementing the technology, I feel it is important to keep abreast of the most current research on best practices to determine the most effective means to get the most of the investment in the technology as opposed to just using it for the sake of using.

Definitions of Terms

One-to-one (1:1) device: a portable computing device set up for the use of one individual student in a classroom setting, popularized after the advent of the iPad in 2010.

Tablet, or *tablet computer*: a flat, rectangular portable computing device where the primary interface is its large, touch-sensitive screen.

iPad: a general term given to a series of tablet computers manufactured by Apple starting in 2010 and run with their iPadOS (or iOS on older models) operating system.

Android tablet: a general term for tablet computers of various manufacturers and run on Google's Android operating system.

Chromebook: a general term for inexpensive laptops of various manufacturers with a touch-sensitive screen run on Google's web-centric ChromeOS operating system.

BYOD: an acronym for "Bring Your Own Device," which is a system of implementation of 1:1 devices where the student is responsible for the purchase of their own computing device, typically within the constraints of certain parameters for system and curriculum requirements.

Chapter 2: Review of the Literature

The purpose of this literature review was to examine the use and outcomes of the technology as it has unfolded since its introduction only a decade ago. In Chapter 1, relevant background information and first impressions of the new technology were introduced. This chapter is organized into three major categories as they relate to 1:1 devices: implementation, student engagement, and student outcomes. Twenty-one studies are reviewed here.

Implementation of iPads and Other One-to-One Devices

iPads, as well as other computing devices deployed on a one-to-one basis, show much promise in the education field. Increased access to information has been a clear benefit to students and teachers (Henderson-Rosser & Sauers, 2017). Another benefit found has been the ease with which the technology has been used to differentiate instruction, as the technology can adapt to the needs of the individual. (Milman, Carlson-Bancroft, & Boogart, 2014). In a study by Blikstad-Balas and Davies (2017), the push for one-to-one devices have been following a shift in pedagogical changes to focus on "21st-century learning" as well as logistical and economic reasons. They also mention that there are new curriculum areas opened up by the use of computing technology, coding being one, and that the most popular app on the iPad has been, surprisingly, the camera and its use in self-evaluation and for documenting student work.

Another study showed that iPads can be used to recreate traditional learning activities in a more easily portable way, eliminating the need for the storage of manipulatives (Larabee, Burns, & McComas, 2014). The use of tablets to supplant traditional textbooks is even seen as beneficial by pediatricians, noting that it's recommended that students only carry no more than 15% of their body weight in their backpack and more than 13,700 children aged 5-18 were

treated with backpack-related injuries in a study done by the US Consumer Product Safety Commission from 2011-2012 (Larson, 2015). These injuries could be alleviated if the combined weight of several textbooks were to be replaced by an iPad, which weighs but 1.07 pounds (483 grams).

However, Blikstad-Balas and Davies (2017) also mentioned the limitations and missteps in the deployment of one-to-one devices, starting with the students themselves being dissatisfied with how they have been assigned to use them. Students in their study lamented that, while they would not choose to be without them, the devices were underutilized or awkwardly shoehorned into instruction and that much of their use was for more their own purposes. Another study showed wide inconsistencies in how devices are implemented, with some schools allowing for BYOD, some requiring students to purchase from a list of approved devices, and some schools that provide one type of device for every student. They also bring up the varying degrees of classroom management issues brought on by the implementation of one-to-one devices, with students having to work under different rules from class to class and teachers feeling like they have to "police" screen time. Lessons that don't use devices also are impacted, as teachers tend to need lengthy periods of time at the start of class for waiting for students to put them away (Selwyn et al., 2017).

Schools fall into the trap of merely providing the devices without much training or shift in instruction, and many schools have them as an add-on to their instruction rather than rewriting lessons to fully utilize the technology (Henderson-Rosser & Sauers, 2017). A thorough integration of 1:1 devices in the classroom has the potential to create a shift to constructivist practices and new, innovative means of learning, many educators simply use the devices to

support their existing, more traditional methods of teaching instead. Schools have adopted a "standard approach" where teachers are simply trained on how to use the technology, and that it is sufficient that teachers merely integrate it into their current practices. Teachers end up lacking the deep understanding necessary to do anything transformational with the technology (Maboe, 2018). Many students have experienced these technologies outside the classroom and are aware of their capabilities as well, and poor implementation on the part of teachers means that those expectations fall short (Chou & Block, 2019).

Many educators also fall into assuming that current K-12 students are digital natives and that the use of the devices just comes naturally to children (Selwyn et al., 2017). Students also fall into this false assumption that knowledge of the devices comes naturally to their peers, as was demonstrated in a study of a pilot program introducing iPads in the classroom where some learning activities included peer tutoring (Watkins, Smith, & McBeth, 2019). These are powerful tools for gathering information, and the sheer vastness of everything that can be accessed can cause students to be frustrated and overwhelmed (Henderson-Rosser & Sauers, 2017).

Students having their own device from the school has also lost its novelty, as many of them have access to their own outside of school (Blikstad-Balas & Davies, 2017). One more limitation is the lack of quality in the devices themselves. Many apps are developed by people with little expertise in academic intervention, so heavy teacher guidance is needed to get the most out of the tools (Larabee et al., 2014). Parent buy-in can be problematic as well, as a study in using tablets to teach reading showed that the use of audiobooks improved literacy skills in similar ways as traditional reading instruction with printed text, but parents surveyed afterward

were not convinced that this was true reading instruction (Maboe, Smith, Banoobhai, & Makgatho, 2018). Tirado-Morueta, Berlanga-Fernandez, Valez-Villamarin, Guzman-Franco, Duarte-Hueros, and Aguaded-Gomez warned in a 2020 study that educators need to move beyond the novelty of the technology, and that we must look to using them for learning activities that are more meaningful and stimulating.

Student Engagement

Despite the issues, deploying one-to-one devices for students seems to be worth it sheerly for the increase in their engagement with learning. In a study by Milman et al. (2014), it was found that 83.9% of educators surveyed perceived an improvement in engagement and 58.1% perceived that students worked harder on assignments with iPads. When students were allowed to take their devices home, it was found that those students engaged in technology for academic purposes more often than recreational purposes when compared to students who did not have a school-issued device (Li & Pow, 2011). Communication between students for academic purposes increased (Henderson-Rosser & Sauers, 2017), and students were also found to do more peer-to-peer tutoring when assigned their own computing device at school (Li & Pow, 2011). There are greater instances of "authentic learning" when students are using the devices to actively interact with peers for learning (Tirado-Morueta et al., 2020). Students are allowed more freedom and creativity in presenting their work and communicating their ideas (Henderson-Rosser & Sauers, 2017), and teachers found that computing devices made it easier to organize and manage student work, and they greatly improved their ability to communicate with parents and share student work (Milman et al., 2014). Students using tablet computers were found to enjoy doing schoolwork more and were more eager to show the results of their work to teachers

over counterparts that were learning the same content with traditional textbooks and methods (Mendez, Mendez, & Anguita, 2018).

The nature of learning activities based around computing technology were found to be more student-centered and student-led (Moon, Wold, & Francom, 2017). Students are more able to set their own pace, and the technology is better able to adapt to individual learning styles (Henderson-Rosser & Sauers, 2017). Students are more motivated to learn with 1:1 computing devices because it gives them more control over their own learning experience (Mendez et al., 2018). Provided that the activities done on the tablets are ones that satisfy the "psychological needs for autonomy, relatedness, and competence," students are academically engaged with the devices (Tirado-Morueta et al., 2020). When teachers introduce the appropriate app with confidence and allow for student autonomy in learning, students have had very positive reactions to the technology and have been highly motivated to participate in learning (Blikstad-Balas & Davies, 2017).

Having one-to-one devices, particularly tablet computers like the iPad, are a boon to reading instruction. Texts on tablets were found to be "more useable" than printed text with the additional features afforded readers (Connell et al., 2012). When doing a reading intervention activity on the iPad versus using traditional manipulatives, student time on task was comparable (Larabee et al., 2014). Students were more engaged with reading for increased fluency when they could record themselves and evaluate their reading as opposed to reading to a teacher or peer, and they were found to want to re-record themselves to hear themselves improve (Ness, 2017).

Students also become more engaged in writing with 1:1 devices, especially in the cases where the curriculum has adapted for multimodal writing, or writing in media other than the traditional pencil on paper. A study noted that teachers found that students thought of work on their iPads to be "fun and exciting," and that writing was not perceived to be work by students. Opportunities for creativity were perceived to be wider with the use of iPads, and cooperation between students was perceived to be increased. Even amongst students who were unable to bring school devices home, there was an increase in interest in writing outside of school, and students who had previously been reluctant to write were seen to be more engaged in writing (Dunn & Sweeney, 2018).

Student Achievement

Milman et al. (2014) lamented that there has been little to no opportunity to observe the effects of one-to-one computing devices on student achievement, and as many as 29.6% of teacher populations they surveyed said that there was no perceived difference at all. In a later study of statewide standardized graduation assessments, no significant difference in achievement between classes with and without one-to-one devices was found (Williams & Larwin 2016.) Reading from electronic devices versus from paper resulted in statistically similar comprehension scores (Sackstein, Spark, & Jenkens, 2015). In another study on reading interventions, doing the activity on an iPad saw student improvement that was comparable to using traditional materials (Larabee et al., 2014). Maboe stated in a 2018 study on using tablets for reading instruction, "Learners with learning disabilities who listen to audiobooks demonstrate increased literacy skills and reading ability." Further, Connell et al. (2012) assured us in their

study that, at the very least, the use of a tablet computer in reading instruction does not decrease a student's comprehension.

The use of one-to-one devices have not consistently been seen to make a difference across the board, but there have been significant changes for particular populations of students. Hispanic students who had access to their own devices saw an increase in their scores on statewide standardized tests when studied over the course of 5-8 years (depending on the time of implementation of the program), but African American students saw a decrease (Williams & Larwin, 2016). Students with IEPs were found to have their scores decrease in the first 2 years, but in the following years there was an overall increase in scores (Williams & Larwin, 2016).

In one-on-one instruction, using iPads was found to yield higher than expected gains in reading comprehension (Moon et al., 2017). Reading time was initially found to be slightly slower on a screen than on paper when the technology was newer (Connell et al., 2012), but newer screen technologies have come closer to the clarity of paper and reading speeds have been found to be comparable or faster than on paper (Sackstein et al., 2015). In a study in Taiwan, English language learners showed greater improvements in their English skills using self-directed learning on the iPad when compared to students receiving the same instruction and content in traditional ways (Wang, 2017).

A 2017 study comparing math instruction with and without tablets found that students' ability at problem solving was increased with the use of tablet computers, provided that the instruction was delivered in cross-curricular learning. The nature of tablets is that it allows for learning across subjects concurrently, and the authors of the study created an app that taught concepts of time in a variety of ways and alongside other topics. When compared to students

learning the same concepts of time within the constraints of a traditional, subject-exclusive math class, the students with the tablets fared better in understanding and ability (Volk, Cotic, Zajc, & Istenic Starcic, 2017).

Moreover, a difference in achievement may not have been found with the overall use of one-to-one computing devices, but it was found that the type of device did make a difference. Students who were issued netbooks (the most common one being the Chromebook) saw gains in their standardized test scores over the years, while those issued iPads or full-featured laptops did not (Williams & Larwin, 2016). Alternatively, a study of tablet computer-use for instruction found that the tablet format was the ergonomically ideal form factor in that it best allowed for students to conduct their learning in multiple positions, allowing for the most free bodily movement to avoid being sedentary. They also found that the touch screen of the tablets made for better refinement of fine motor skills amongst students (Volk et al., 2017).

According to a 2017 study, the most significant contribution to education brought on by this technology is not the proliferation of the devices themselves but the potential for the shift in pedagogy. Teachers who were fully trained to take advantage of the wide range of applications available for learning were able to start shifting from a teacher-led model to one where the role of the teacher was more that of a coach or facilitator while students were the drivers of their own learning. Where teachers did not take full advantage of the possible shift in the way they taught, they at least saw the benefits of improved communication, faster access to information, and easier means to provide feedback to students (Geer, White, Zeegers, Au, & Barnes, 2017).

Summary

The findings of research on the implementation of 1:1 devices in classrooms present a mostly positive picture. Positive results have been dependent upon the level of commitment each educational institution has shown in implementation, with better results coming from classrooms, schools, and districts that have used the technology to transform the learning experience rather than overlay it upon their existing curriculum. Other primary factors influencing the successful implementation of the technology have been how the devices have been deployed and whether or not the students are allowed to make use of them outside of the school environment. While no one implementation has been seen as the one to model all implementations off of, there are some general trends that are seen as indicators of whether or not the program is being set up make improvements in academic achievement. Conclusions and recommendations are discussed in Chapter 3.

Chapter 3: Action Research, Methods, Findings, Conclusions and Recommendation

The purpose of this research paper was to study the implementation of 1:1 devices in classroom settings and determine their effectiveness, if any, on student achievement as well as evaluate the conditions under which the technology is implemented. In Chapter 1, I provided background information, and in Chapter 2 I presented a review of research literature. In Chapter 3, I discuss my own experiences in the field, findings, recommendations, and implications from research findings.

Methods

Over the course of 3 years, I actively took part in the implementation of 1:1 devices in three different educational settings. These schools were chosen for my action research out of convenience, as they were the institutions that were available to me. What follows in the next sections is an account of experiences observed, comparisons of actual classroom occurrences to best practices found in research, and outcomes of the practical usage of 1:1 devices in the classroom. With each school, I describe the devices used and their implementation, what the intended use of the devices were as instructed by school administrators, and how the devices were actually used in each setting. In the conclusions, I describe the successes and failures of the systems in place in each school, the support structures in place in each school as they pertain to the devices, the students' usage of the devices, and compare the application of the devices in the field to the research found in the literature.

Research Scenario

I investigated my research at three schools, all implementing 1:1 devices in distinctly different ways. Classrooms studied include three upper-elementary settings, two public schools

(one urban and one suburban), and one private school. The two public schools had district-provided devices, while the private school was BYOD. In each scenario, the teacher observed was a new hire with prior teaching experience, placed in the classroom with limited training on the use of the devices but with the expectation that the devices be used for certain educational activities. Student population varied, with the private school and the suburban school being primarily of white students and the urban school being almost exclusively minority students.

Public School A

Public School A was an elementary school (K-6) in a suburban district of a Midwest metropolitan area. The classroom primarily observed was one of three sixth grade rooms in the school, all of which exclusively use 1:1 iPads.

Devices. Each student was provided an iPad by the school district, and as each iPad was set up specifically for that student, students were automatically signed into instructional software that required individual accounts. This device is intended to serve the student from sixth grade (their final year of elementary school) up to ninth grade (their final year of junior high), whereupon they will receive Chromebook laptops at the high school level. Each student was provided an account through the Google Suite for Education, which allowed them access to email, cloud-based storage, and a suite of productivity applications. The iPads accessed applications strictly through the district's Self-Service app as opposed to Apple's own App Store so that only district-approved apps would be installed. Students were not allowed to take their devices home at this grade level in any classroom in the district. A set of keyboards was also provided to each classroom, but only enough for a third of the students to use them at any one time.

Instructional staff were also provided with iPads, either one that matched the student devices to augment the district-provided laptop or an iPad Pro that served the dual purpose of instructional device and work computing device. All iPads provided to the staff also had unfettered access to Apple's App Store and was preloaded with Apple Classroom, a device management app that allows the monitoring and control of student devices. Classrooms were outfitted with a projector-based interactive whiteboard manufactured by Promethean, and teachers who opted to use the iPad Pro were also provided an Apple TV for the purpose of screencasting from their iPad.

Instructional Intent. The district was in its fifth year of their 1:1 iPad program. The primary intent of the devices was to introduce the students to the concepts and practices of learning with the iPads, and many of the lessons surrounding their use was geared toward teaching behaviors and usage skills. There was no specific curriculum written for the devices, but teachers were encouraged to make use of various school-provided teaching tools as well as the Google Suite for Education (used in lieu of Apple's productivity suite so that student accounts could be used at the high school level), and emphasis was placed on students learning the school-provided portal for managing student grades and assignments. Outside the standard productivity and student management apps, also provided at this school for sixth grade was IXL, a service that provides a standards-based set of lessons meant for independent learning through its website and app, Epic!, a service that provides ebooks and audiobooks, and the digital version of *Northern Lights*, the text for the social studies curriculum. Staff resources available to teachers was a part-time technology mentor teacher, which was shared with another school in the district, the building IT manager, and the building media specialist.

Practical Application. Ultimately, it was up to the individual teachers to determine the degree of usage and instructional purposes. An array of implementation was observed amongst the four sixth grade teachers (the classroom studied was taught by two half-time teachers that split their time between AM and PM), from one teacher using the tablets for most schoolwork to one teacher almost refusing to use the tablets for various reasons, most relating to unfamiliarity with the use of the devices and a perceived lack of control. A frequent use for the tablets was to avoid having to use the school's central computer lab. As the devices were restricted to use at school, all instructional usage of the tablets was restrained to the classroom. Students could not be required to continue any assignments on the iPad outside of school, so time had to be given during the school day from completion of any instruction on the tablets. Students who had access to a computing device at home were able to, and did, log in to resources from there, but they were at an advantage over students who did not have such access.

Public School B

Public School B is an elementary school (K-5) that is part of the district in the core city of a Midwest metropolitan area. The classroom primarily observed is one of two fourth grade classes and has enough devices so that every student can use one concurrently, but devices are not assigned to individual students like in a true 1:1 setting.

Devices. Provided for instructional use specifically for this classroom was a cart containing 13 Chromebooks (originally 16), and this was augmented with seven iPads from a set of 28 that was intended to be shared amongst four classrooms. While it was district policy to strive for each student to have a computing device available to them in the classroom, it was not the case that each student had one assigned to them or necessarily that there were enough devices

in every classroom for each student. Students had a portable profile that they were able to access once logging in to the Chromebooks, or they accessed their accounts for various district-provided applications and services through the Clever app on the iPad and a QR-code badge. Each student was provided an account through the Google Suite for Education, which allowed them access to email, cloud-based storage, and a suite of productivity applications. As the Chromebooks were operating Chrome OS, applications for the Chromebook were entirely web-based and extensions were only allowed to be installed by the systems administrator. The iPads accessed applications strictly through the district's Self-Service app as opposed to Apple's own App Store so that only district-approved apps would be installed. As the iPads were provided by the individual school to supplement the classroom set of devices, the Chromebooks were the district's preferred devices and were supported as such by the centralized IT department. Staff resources available to teachers were a part-time IT administrator shared with another district school, the building media specialist, and a literacy specialist.

Instructional Intent. The devices provided were intended for use for individualized instruction. Use of the devices was up to the school to implement, and primarily the applications used were Lexia Core5, a standards-based literacy program meant to be used independently, and either Dreambox or Prodigy, similar applications provided for math (teachers chose one or the other, and in the classroom observed Dreambox was used). Occasional testing was done on the in-classroom devices, but much of this was also done in the computer lab.

Practical Application. The common practice in the building, as prescribed by the literacy specialist, was to make use of the devices during small-group rotations during the literacy block each day. The literacy block was typically alternated between 10- to 15-minute

mini-lessons and 10- 15-minute blocks of time for working with small groups. During this time, students not with the teacher were either silently reading or writing or doing lessons through Lexia Core5 on devices. As there was no means to monitor student screens as they worked, some students did not feel obliged to participate, nor were there staff members in the room available to assist. Students had a tendency to neglect their academic work when left unattended.

The inability to assign a device to each student specifically was not ideal, especially for a classroom where low student performance meant that every minute of instructional time needed to be maximized. The additional time it took for remembering complicated passwords and logging in to the computer and then an application resulted in less time than if the students were to have a device dedicated to them. Students with low reading abilities had difficulties in using the Chromebooks, and they gravitated instead toward the icon-based iPads. One student in particular was hampered by an inability to type in a username and password, resulting in even more lost instructional time if a staff member was unable to assist immediately.

As the devices were not permitted to go home with students, all use of the devices was restricted to the classroom and time for completion of activities had to be included in planning. While students were made aware that they were able to log in to their Google accounts, Lexia Core5, and Dreambox, but it was rare that any student took the opportunity outside of school to extend their learning through the technology provided.

Private School

The private school observed in this study is a for-profit school in the suburb of a Midwest metropolitan area. The classroom observed is fifth grade and has 1:1 Android tablets.

Devices. Students grades 3 through 8 were required to provide their own Android tablets. A set list of minimum requirements was given, and it was the responsibility of the students and families to purchase and maintain the devices. There was no uniformity across devices, nor was there hardware support provided. Students had access to the full Google Play store, as these were unmodified tablets as is typically purchased for personal use. Legally, parents were required to install software and accept the terms of service, and no staff member was to install software or have students install software on their own. The only resource staff available to teachers was the building IT manager, and the only support provided was for the school's proprietary app.

Instructional Intent. The devices were required specifically for accessing the school's proprietary app, which was developed only for Android. Initially, teachers were instructed to connect the tablets to the school Wi-Fi strictly for downloading electronic versions of the school's self-published textbooks, and then they were to remove access from the network. Once downloaded, elementary students were only to use their tablets for accessing the books loaded on to their devices. It was the stated preference of the parent company of the school to use the electronic version of the textbooks over the paper versions, but it was not a requirement to do so.

The classroom observed received special permission from the school's corporate office to use the devices beyond what was permitted. The school's Microsoft Office 365 license provided for 1,000 student accounts, and each student in the one 5th grade classroom was granted access to an account. Students were specifically requested to install OneDrive, Word, PowerPoint, and Excel for the purpose of creating, editing, and sharing documents for instructional purposes. The writing curriculum was particularly augmented with the additional requirements that students

type all final drafts and submit all work by sharing the documents with the teacher (use of Outlook and email was not permitted). Use of the tablets became part of the required writing process, and students were obligated to not only submit their work digitally but to respond to comments made on their work and improve their writing accordingly.

Practical Application. Generally, teachers in the school did not follow the guidelines set for student tablet use. In practice, the use of the printed textbooks was highly favored over the electronic versions and the tablets were mostly unused. It was common for students to not have their devices. In the observed classroom, the printed texts were still preferred but the tablets were used more heavily as their use was required by the teacher for the writing curriculum. In most classrooms, the tablets were even seen as nuisances or the teachers were not willing to realize their full capabilities as their use was not part of the prescribed curriculum. One teacher once lamented that there were no computers available in the classroom as had been in the past, ignoring the fact that the tablets themselves were computing devices. In-school technical support was only provided for the one proprietary app published by the school.

As the tablets were the personal property of the students, work was able to be completed outside of the classroom. Obtaining access to an internet connection was not an issue with any of the students, as that is a common concern when sending devices home for students to complete work. It was noted that a few students had submitted homework assignments past 9 pm. Students often had an array of non-academic applications on their tablets, and many students across all classrooms were in the habit of using the tablets outside of school for leisure rather than academics.

Conclusions

Public School A. Public School A had the most uniform and most complete implementation of devices amongst the schools observed. A comprehensive training was provided in the initial rollout of the devices, and there was continued support for their use in place. Students and teachers were all on the same device, had access to the same versions of the same applications, and the familiarity made it easy for teachers to support their students. This compares to Middleborough in the Selwyn et al. (2017) study, where the uniformity of devices led to an easier adoption of the technology. Also, in both Public School A and the Middleborough school, well defined guidelines for device usage amongst students were set by the school administration, and teachers felt more comfortable with introducing the devices to students with the clear directives.

However, Public School A did not seem to have a clear curriculum for the usage of the devices other than to prepare students for their use in later school years. Teachers were reluctant to give up instructional time for students to use the devices, as they were not allowed to make use of the devices outside of class time. The inconsistencies in the use of devices by teachers can be compared to Blickstad and Davies (2017) where, looking across classrooms, student excitement and engagement with the tablets waned when it was evident that teachers were less likely to use them. Student interest in devices also waned when it was apparent that teachers were simply using them as replacements for traditional classroom teaching tools like worksheets and textbooks (Blickstad & Davies, 2017). Here was seen a similar mismatch in expectations of students as observed by Chou and Block (2019) where students were facing the promise of a redefinition of learning and instead saw mostly that the devices were used to replicate more

traditional analog learning activities. The most common uses of the iPads were analogous to tasks that were already being done on paper prior to the deployment (assignments being managed through Google Classroom or grades and assignments being checked periodically), and as there was no defined integration of the devices into the curriculum anything done with the devices was a "value added" activity or enrichment and not necessarily transformational.

Public School A had the most successful deployment of 1:1 devices of the three schools observed. Having uniformity in the type of devices, clear expectations of their use, and the support and infrastructure of the school administration made for an easy adoption of 1:1 devices (Selwyn et al., 2017). While it lacked the transformational changes that having access to the devices has the potential to bring, the investment in the infrastructure and support at least put the devices in the hands of students. As with other schools that have had a full 1:1 implementation, with further training and continued use, a shift could happen for the school to realize more potential from the devices (Geer et al., 2017).

Public School B. Public School B only barely could be considered a 1:1 school, despite that being the purported goal according to the IT manager. While it was technically true that there was one device per student, at least in the classroom observed, the devices were not specifically assigned to individual students. There was some modicum of individualization in the setup as student profiles were portable on the Chromebooks and logging in to any of those devices gave the feeling that it was set up for that student. With the transient nature of the student population, though, this could be seen as a preferential setup. Students transferred schools more frequently than in the other schools studied, as some had unstable housing or home lives, and transferring a virtual identity was far easier than having a device move with the student

and could still give the illusion of the district being 1:1. However, as a third of the devices were iPads, the illusion was shown to be just that.

The inconsistencies in types of devices also led to similar problems to the Mountview school in the 2017 study done by Selwyn et al. While the Mountview school was a BYOD school and Public School B was not, in both cases the result was a mixture of devices on different platforms. The increase in instructional time used for teaching students the different ways to access resources led to a decrease in interest to use the devices. Both schools had a higher number or low-income students, and this led to implementation decisions in terms of which devices to deploy that were supposed to be accommodating but instead led to a disservice to students due to incompatibility and inconsistency. Mountvew allowed for whatever devices students had on hand to be used, including smartphones (Selwyn et al., 2017), while Public School B had teachers scrounging for whatever devices were available to meet a directive for each student to have a device.

There was also a different attitude toward the different devices, similar to what was seen in Blikstad-Balas and Davies's (2017) analysis of the Los Angeles schools' deployment of 1:1 devices. In both Public School B and the Los Angeles district, the iPad was viewed as a more "fun" device, while the Chromebook was viewed as a "work" device, in addition to the iPad being selected in Los Angeles for its ease of use for younger students. In Public School B, similarities were observed in that students preferred to use the iPad, also for its ease of use and it being a more "fun" device to use.

Many of the issues with the deployment of 1:1 devices in Public School B stemmed from the massive undertaking of implementation in a large urban district with limited resources and

heavy bureaucracy. The district comprised of 40 elementary schools, and the support for the devices was centralized at the district office that offered little flexibility. Requests for new apps through Self-Service were typically not granted as the iPads were not the devices preferred by the district office. Extensions and apps on the Chromebooks, such as one that would allow for scanning a badge to log in instead of the laborious usernames and passwords, could only be installed by the part-time IT manager, leaving teachers' hands tied when it came to wanting to try new things. This also compares to the Chou and Block (2019) study where teachers and students faced the frustrations of inadequate and overly bureaucratic centralized support from a district IT department attempting to deploy devices across several schools at once.

Public School B is an example of how not to do a 1:1 device implementation in a school district. It was not a true 1:1 deployment as each student did not have a device dedicated to them, and even in the classrooms where there were enough devices there was a mix of devices. The stated goal of the district may have been to become 1:1, but it was premature to call it that at the time. As forewarned in the Bilikstad-Balas and Davies (2017) study, despite student interest in the devices they were not well integrated into the curriculum.

Private School. The Private School was a fascinating dichotomy of having the devices in place and advertising that the school was on the forefront of technology in the classroom while at the same time restricting the use of said technology to the point where it was hardly used at all. Even the one approved app, a proprietary app that had the school's own textbooks and student management system, that was the reason for requiring the tablets in the first place was rarely used at the elementary level. The limited use of the tablets, even in the one classroom where expanded use was allowed, was not transformational at all.

The Private School was indeed successful in deploying 1:1 devices under a BYOD model in a similar fashion to the Lakeside school in the Selwyn et al. study of 2017 in that students were given a set of system requirements but were responsible for the purchase and maintenance of their own devices. Unlike Lakeside, though, the culture of the school was such that it was not set up for experimentation with or widespread use of the devices. Concerns amongst teachers and administration mirror the concerns of the Chou and Block (2019) study, where there was a feeling that the tablets opened up the classroom to disruptions or cheating, except that in the Private School it led to an intentional disuse of the technology.

Where there is a will, there is a way, though. Similar to the Li and Pow study of 2011, student collaboration facilitated by the tablets did occur without prompting from the teacher, as did an increase of academic use of devices outside of the school setting. Currently the tablets are intended for use as replacements for textbooks, and if the use is promoted it will increase student motivation.(Mendez et al., 2018). This school could be the most likely to maximize the potential of 1:1 devices; however, as record low enrollment and a competitive education market could be catalysts for change.

Limitations

The largest limitation of this study is simply the newness of the technology. Computing technology has been a staple in school settings for decades, but the concept of every student in a K-12 setting having their own internet-connected device as the norm only truly came into being since the advent of the iPad in 2010, and it was not long before that reliable, high-speed internet access was common as well. With less than a decade's use to study the technology, our understanding of its use is in the nascent stages (Selwyn et al., 2017). While there are some

studies that have shed light upon the current state as well as short-term effects of the technology, a look at the long term just is not possible right now (Blikstad-Balas & Davies, 2017).

Another limitation of the study was the use of the devices themselves. While there is potential for 1:1 computing devices to be transformational, the shift in pedagogy to take full advantage of the technology is not happening. As seen from my own experience and several of the studies referenced, the devices were often used as substitutions for older ways of doing things, such as distributing and collecting schoolwork or for accessing a digital copy of a print textbook. There are certain benefits to the efficiencies provided by the technology, but simply doing things faster isn't enough to truly differentiate between the learning experiences of students with or without. The difficulty in studying whether or not the technology could make a difference was in that they weren't used much different than the traditional tools of the classroom.

The dearth of real change in the way we teach is attributed to the third limitation, which is the lack of training for teachers on the devices, or rather the lack of the right training. Chou and Block (2019) demonstrated this as well, in that they had troubles collecting data in their study due to inconsistencies in the level and quality of training of teachers and their understanding of the concepts in the research. Much of the training received was procedural, or how to work the devices. To really see that transformational shift in the way we teach, which is the promise of this technology, there needs to be a shift in the way that teachers are trained to teach as well (Blikstad-Balas & Davies, 2017; Geer et al., 2017).

Recommendations

While there is no one right way to implement one-to-one devices in an educational setting, there are some commonalities between successful deployments that institutions cannot ignore.

It's critical to have a pedagogical shift when implementing the devices. Having a computing device for every student can be a huge convenience, allowing access to information without having to take time to use a dedicated computer lab or share resources, or allowing for faster dissemination of assignments through digital means. Certainly there are benefits in the cost savings of not maintaining a separate computer lab or increasing the speed at which we can get information to students, but using it just for the convenience is not transformational, nor is it going to allow the use of the devices made a meaningful impact on student learning. Included with the deployment of this new technology, there needs to be a change in mindset in how we teach. According to Geer et al. (2017), teachers are moving in the direction of changing the way that they teach once 1:1 devices are introduced, moving further from a teacher-centric methodology of instruction to one that in centered around "research, communication, self-reliance/autonomy, and authenticity." With putting a device in the hands of every student in the classroom, the dynamic is changing from a teacher-centric method of instruction to one that is centered around the student. As teachers better understand how to implement the technology, the method of instruction is moving toward one that recognizes that students have far easier access to information than they had in the past (Geer et al., 2017). Blickstad-Balas and Davies (2017) asserted that appropriately selected apps integrated into the curriculum by a confident teacher contributed greatly to the quality of the learning experience, and that 1:1 devices "expand the

scope and quality of students' understanding of the world" when properly used. I recommend that, along with the deployment of this technology, the student learning experience shifts to a more connectivist philosophy, allowing for the student to not just find meaning in what they create but to also connect it to the wider community.

One aspect of 1:1 devices is their purported use to individualize student learning, so it seems contradictory that I would recommend a standardization of devices for deployment. It is the apps and their implementation that provides the individualization, though, and the choice of machinery to provide that delivery is of little consequence except when it is inconsistent. Implementing new technologies into learning is difficult enough, especially when that technology has the potential to have far-reaching changes as this one, and a clear way to ease that transition is to have everyone on the same hardware. Compatibility and a common familiarity are both key to successful deployments of these devices as having everyone on the same device eliminates frustrations that deter teachers and students from wanting to use them. A hodge-podge of devices, as seen in Public School B, increases the time spent in managing the transfer of information between unlike devices, time that could be spent in instruction or use of the device. A BYOD approach, as seen in the Private School, may be seen as a means for educational institutions to implement 1:1 devices without the cost to the institution, but it provides the same inconsistencies that deter use as non-conformity besides also typically having the practice of not providing technical support for the devices. My experiences with Public School B and the Private School were not dissimilar to the Lakeside and Mountview schools where a variety of devices combined with a lack of IT support made implementation of the

technology difficult, and the uniformity of devices in Public School A and Middleborough alleviated many of those barriers (Selwyn et al., 2017).

As my last recommendation, to be transformative and take full potential of these devices they must be allowed for use beyond the classroom. Computing devices are a part of modern, everyday life in the form of computers, tablet computers, smartphones, video game platforms, and other means of digital content consumption and creation. Students can and do use these for their leisure, and they will do so with a computing device set up for use in an educational setting as well. The difference between the school device and the personal device is that students' use of the school device is of a more academic nature, as was seen amongst the students of the Private School as well as students in the Li and Pow (2011) study. It is still leisure, but when the school device is chosen students tend to engage in exploration that enhances their learning. Connectivism has a grounding in constructivism and limiting the use of the devices to just school hours also limits a student's opportunity to freely explore and create with the device. The 2019 study by Watkins, Smith, and McBeth also highlighted the importance of allowing the devices outside the classroom, recognizing that the work of learning does not happen only within the walls of the school. While methods do exist for students to access their learning resources and projects without physically having the device, both Watkins et al. (2019) and my own experiences in the public schools show that the workarounds are unnecessarily complicated when there exists the simple solution of allowing the device to go with the student. Another piece of this recommendation is that institutions need to provide for or help facilitate internet access outside of the school building, as the power of these devices lies in their ability to connect to the world wide web. Students of lesser means or in rural areas, both seen in Public School B and

Mountview, need the infrastructure in place for them to connect their devices (Selwyn et al., 2017). There is potential for students to engage in truly independent learning, provided that institutions allow for and support it.

Implication

The majority of the studies in my research have stressed that this technology is growing in popularity. In my own suburban area, open enrollment and school choice have set the stage for a highly competitive market for K-12 education. Many of the advancements in the realm of education locally have been fueled by a need to keep students within home districts and attract students from other districts to replace the students that inevitably leave. 1:1 devices is the hot, new advancement in education at the moment, and districts and schools in my locality market themselves as being on the forefront of technology (Minnetonka Public Schools, 2020). There are also schools that expound their intentional lack of 1:1 devices, stating philosophies that the technology is nothing more than a distraction, and these schools are not wrong in the cases that the implementation is done incorrectly (Hinrichs, 2017). Regardless of the naysayers, the technology is here to stay, and it is being put into use worldwide, and anything worth doing is worth doing well.

Our modern world is ever shrinking, much in part to the technology behind the 1:1 devices and the skills that put them to use. Companies are looking across the country and the globe for talent, so a needed skill in the workplace today is the ability to connect and work with others through a screen. Even when we have the ability to work with others face-to-face, the collaborative skills inherent in the use of the technologies offered with 1:1 deployments are

beneficial in any workplace. Watkins et al. (2019) also noted the benefits of applying real-world collaborative computing skills in the classroom with their study of a pilot iPad program.

Ultimately, it is the way that the use of these devices motivates students to take charge of their own education, the way that the learning experience can be individualized for the students, and the way that the technology opens students up to more opportunities to be cooperative and collaborative that should drive the adoption of 1:1 devices in the classroom. The technology itself is not the sole catalyst for change but is a platform upon which the student is the driving force behind creating their own understanding of the world and sharing that understanding with the greater populace (Geer et al., 2017; Selwyn et al., 2017).

Summary

Positive results have been dependent upon the level of commitment each educational institution has shown in implementation, with better results coming from classrooms, schools, and districts that have used the technology to transform the learning experience to one that is based on connectivism, using the technology to create a learning environment that is tailored to the individual and teaches through connecting with knowledge and other individuals and creating new content to demonstrate understanding. Other factors positively influencing the successful implementation of the technology have been a uniform, centralized deployment of devices, thorough and constant training for teachers, and the support and infrastructure for students to make use of the devices outside of the school setting. One-to-one computing devices have the potential to be the backbone of a student-centric, individualized, and connectivist learning environment for our students.

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