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1:1 Computing Initiatives: How They Can Be Sustained

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ACCEPTANCE

This dissertation, 1:1 COMPUTING INITIATIVES: HOW THEY CAN BE SUSTAINED, by BOBBY VIRGIL COLE, JR., was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Education, in the College of Education and Human Development, Georgia State University.

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1:1 COMPUTING INITIATIVES: HOW THEY CAN BE SUSTAINED,

by

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ABSTRACT

Background: One of the fastest growing and most expensive initiatives over the last decade has been 1:1 computing initiatives. However, despite positive impacts on educational outcomes, some systems have discontinued these programs.

Purpose: The purpose of this qualitative study was to understand key factors that enabled the successful implementation and sustainment of 1:1 computing initiatives.

Literature Review: The purpose of the literature review was to highlight the history of technology in education, provide an overview of the current impact of 1:1 computing, and examine the barriers to sustainability of these initiatives.

Research Design: While the philosophical basis of the qualitative approach employed in this study was phenomenology, an overarching constructivist theoretical perspective was used in framing the design of this research.

Data Collection and Analysis: Based on the data collected from personal interviews of nine superintendents where 1:1 computing initiatives have been successfully implemented, an analysis of the data revealed several key themes.

Results: Through the interviews of the nine superintendents, several themes emerged after analyzing the data gathered. The five themes identified were: vision and planning, teaching and learning, resources, technology suffused world, and equity.

Conclusion: As more policymakers and system leaders are adopting and allocating more resources for this popular initiative, a sound understanding of these key factors has become increasingly essential. By considering certain key factors when implementing and sustaining 1:1 computing, computers have the potential to significantly and positively impact education.

INDEX WORDS*:* 1:1 Computing, School leadership, Laptop computers, Decision making

1:1 COMPUTING INITIATIVES: HOW THEY CAN BE SUSTAINED

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BOBBY VIRGIL COLE, JR.

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DEDICATION

This dissertation is dedicated to my wonderful wife, Mollie, who provided the support, love, and encouragement to make this possible. It is also dedicated to my late grandfather and namesake, Virgil Calvin Cole, who had to quit school at eight years old to support his family but learned to read in his eighties.

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1 1:1 COMPUTING INITIATIVES: HOW THEY CAN BE SUSTAINED

Over the last decade, 1:1 computing was one of the fastest growing, most discussed, and most expensive initiatives in American education (Bebell & Kay, 2010; Lei & Zhoa, 2008; Storz & Hoffman, 2013). By most definitions, "1:1 computing" signifies the access that students and teachers have to technology (Bebell & O'Dwyer, 2010). For instance, Penuel (2006) defined 1:1 initiatives as providing students with a portable laptop that has Internet access, productivity software, and can be used for academic purposes. Whereas 1:1 laptop programs were widespread internationally, the United States was home to several large-scale 1:1 computing initiatives specific to several state initiatives (Bonifaz & Zucker, 2004; Gigliotti, Carrington, & Agostinho, 2013; Bebell & O'Dwyer, 2010; Zucker & Hug, 2008).

Purpose of the study

There has been evidence that 1:1 initiatives have had a positive impact on educational outcomes (Bebell & O'Dyer, 2010; Richardson et al., 2013; Zheng, Warschauer, Lin, & Chang, 2016); however, several United States school systems that adopted 1:1 computing programs are now discontinuing them due to a lack of educational results or failing to live up to lofty goals due to a disconnect between academics and technology (Hu, 2007; Superville, 2016). Bonifaz and Zucker (2004) found that each 1:1 computing initiative was unique and influenced by a number of factors. Moreover, they found leadership was the most significant factor that influenced these initiatives. As policy makers and school leaders decide whether to move forward with this expensive initiative, it is important for them to know what factors influenced leaders who were successful in implementing and sustaining 1:1 computing initiatives. Additionally, some have questioned the evidence that this initiative had improved basic learning (Richtel, 2011), particularly

in relation to the factors that influenced the effective implementation of these programs (Bebell & O'Dwyer, 2010; Keengwe, 2007; Paraskeva, Bouta, & Papagianni, 2006; Zucker & Light, 2009). Consequently, the purpose of this study was to understand the key factors that enabled the successful implementation and sustainment of 1:1 computing initiatives. The literature on 1:1 computing initiatives was limited, particularly on the factors that helped facilitate the sustainability of these programs.

Guiding Questions

The following research questions were addressed in this study:

1. What factors did superintendents perceive to have influenced school districts as they made the decision to implement 1:1 computing initiatives?
2. What factors did superintendents perceive to have helped to sustain 1:1 computing initiatives?

REVIEW

The purpose of this review of literature is to provide a framework for the study of 1:1 computing initiatives as it relates to sustainability. This literature review begins with the history of technology in education. By understanding the historical roots of educational technology and its reoccurring cycles in education, a better understanding is attained regarding the latest manifestation of educational technology in the form of 1:1 computing programs (Cuban, 1986; Saettler, 2004). Next, the review provides an overview of the current impact that 1:1 computing initiatives have had on education. The latest evidence and research indicates that 1:1 computing initiatives can lead to positive educational outcomes, including student engagement, better behavior, increased writing skills, and student achievement (Bebell & Kay, 2010; Cromwell, 1999; Donovan, Green, & Hartley, 2010; Mouza, 2008). The review concludes with an examination of

the barriers to sustainability of 1:1 computing initiatives. Despite indications of some short-term positive results from 1:1 computing programs, there have been some major impediments and criticisms of these programs leading to failure and differences in the initial integration of these initiatives (Cuban, 2015; Hu, 2007; Richtel, 2011). First, however, a common definition of 1:1 computing used in this study is presented.

Common definitions

By most definitions, 1:1 computing signified the access that students and teachers have to technology (Bebell & O'Dwyer, 2010). Additionally, 1:1 initiatives were defined as providing students with a portable laptop or other variations in hardware that had Internet access, productivity software and could be used for academic purposes (Penuel, 2006). For the purpose of this study, 1:1 computing was defined as each student being given a computing device that is more powerful than a smartphone, whether a laptop, netbook, or tablet computer, and having access to that device both in and out of school, including evenings and weekends (Richardson et al., 2013). Since 1:1 initiatives are fairly new in the field of education and research had not kept pace with their rapid expansion, it was necessary to look back at the evolution of technology in the classroom to create a definition.

Saettler (1979) described the two fundamental models or viewpoints of educational technology: the dominant traditional or media concept and the behavioral science concept. In his view, educational technology was to be viewed as a broader conception of educational process rather than a specific or product form of technology. Saettler was one of the first to separate the resource and the instructional process. This was reflected in a more contemporary definition of educational technology that builds on this concept (Januszewski & Molenda, 2008). More spe-

cifically, the Definition and Terminology Committee of the Association for Educational Communications and Technology (AECT) defined educational technology as the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources (Januszewski & Molenda, 2008, p. 1). Cuban (1986) defined instructional technology as "any device available to teachers for instructing students in a more efficient and stimulating manner than the sole use of the teacher's voice" (p. 4).

History of Technology in Education

Historically, the role of technology in education has been a series of trial and error (Saettler, 1979). While the emergence of some technology in education was found prior to the twentieth century, such as the advent of the printing press (Saettler, 2004), this review will focus on the electronic advances since 1900 and the coming of the machine age (Saettler, 1979). Although frequently promoted as the catalyst for educational change, innovation and reform, electronic technology in the classroom has not shown any scalable or sustainable impact on education (Cuban, 1986; Weston & Bain, 2010). By the turn of the 20th century, public schools would have looked similar to present day schools. Schools were divided by grades into separate classrooms with rows of student desks facing the chalkboard (Cuban, 1986). One of the first major electronic technologies for education that was enthusiastically embraced was the use of film in the classroom (Cuban, 1986; Saettler, 2004).

Visual instruction. In the early decades of this the last century, some educators formed associations around the words "visual instruction," which stressed the pictorial content of lectures (Saettler, 1979). While some early inventors and pioneers of motion picture considered it primarily an educational medium, most of the early films were entertainment in nature (Saettler, 2004). The earliest forerunners of educational film were the newsreel, the travelogue, and the

scientific motion picture (Saettler, 2004). Furthermore, the use of visual media or visual instruction in schools actually dates as far back as 1908, when the Keystone View Company published a teacher's guide to lantern slides and stereographs followed by instructional films in 1910 (Reiser, 2001). At the same time, the first educational film catalogue appeared and the first school in Rochester, New York public schools adopted films for regular instructional use (Saettler, 2004). Even Thomas Edison in 1913 declared, "books will soon be obsolete in the schools" (Reiser, 2001, p. 55), and the use of films in the classroom became a symbol of progressive teaching approaches (Cuban, 1986). While this instructional movement grew during the following decade, the changes he predicted did not, and impediments to the use of visual aids soon emerged.

Several factors limited the use of visual aids in the classroom, including the lack of teachers' skills in using this technology, the cost of film and equipment, and reliability concerns with projectors or hardware (Cuban, 1986). During the 1920s and early 1930s, commercial educational film companies were also failing at an increasing rate despite some initial research findings that suggested the usefulness of film in the classroom. An examination of this decline found several factors, including the fact that commercial interests had failed to understand the nature of instruction, businessmen looking for a quick profit lost the confidence of professional educational leadership, heads of educational institutions devoted little time to developing leadership around "educational" motion pictures, and technical problems emerged (Saettler, 2004). While it became a symbol of progressive teaching in the following years, it soon gave way to programmed audio instruction (Cuban, 1986; Reiser, 2001; Saettler, 2004).

The emergence of the radio. The 1920s saw the emergence of a new educational media or instructional technology in the classroom: the radio. For the next ten years, educational radio

flourished and grew, with some educators making wild predictions about radio's impact on education (Bianchi, 2008; Saettler, 2004). One of the most extensive and important uses of this new technological medium in education centered on the School of Air (SOA) movement (Bianchi, 2008). Commercial networks, state universities, departments or colleges of education, and local school boards ran SOAs. SOAs were radio programs intended for in-school use for the purpose of presenting courses of study, assisting with cumulative learning, individual programs of instruction for specific grades, and distributing learning support materials such as teacher and student guides (Bianchi, 2008). The first director of the Ohio School of Air, Ben H. Darrow, declared:

> The central and dominant aim of education by radio is to bring the world to the classroom, to make universally available the services of the finest teachers, the inspiration of the greatest leaders… and unfolding world events which through the radio may come to as vibrant and challenging textbook of the air (Cuban, 1986, p. 19).

Despite his fervent hope in this new educational technology, issues and obstacles soon arose around the use of radios in the classroom.

Similar to the impediments encountered earlier with film, educational radio found itself confronted with several barriers, including equipment and hardware accessibility, and the lack of obtaining feedback from teachers (Cuban, 1984). The overall impact of radio as a tool in the classroom began to wane with the onset of World War II when the enthusiasm for television as an educational tool sparked a new generation of school reformers. By this point, research and journals on radios in the classroom had all but disappeared (Cuban, 1986).

Televisions in the classroom. As radio education declined, the use of televisions in the classroom began to expand as the latest educational technology fad. Televisions, as part of the

audiovisual movement during the 1950s, became the embodiment of this era as a new medium for delivering instruction while renewing optimism for educational reform (Marshall, 2002; Reiser, 2001; Saettler, 2004). In the backdrop of this period was an increased concern for school quality across the nation and improving the quality of instruction (Cuban, 1986). Further stimulating this growth was the setting aside of educational channels by the Federal Communications Commission and Ford Foundation funding (Cuban, 1986; Marshall, 2002; Reiser, 2001). These new public "education" television channels' primary mission was to present instructional programs (Cuban, 1986). Additionally, the Ford Foundation and its agencies sponsored projects to produce a closed-circuit television system that could be used to deliver primary and supplemental instruction in all major subjects across all grade levels without any regard to individual differences (Reiser, 2001; Saettler, 1979). When the total instructional program was delivered by the television, the teacher acted only as a supervisor (Cuban, 1986). Notwithstanding the promise of this new technological medium to change education, interest in using televisions in the classroom began to fall by the 1960s as barriers began to arise.

Some factors that contributed to the decline of the use of television in education and programed instruction, included the lack of teacher involvement and training in the initial implementation process, mediocre instructional quality, external funding for instructional television projects to school districts ending, teacher resistance to this medium, and the inability of televisions alone to create the proper conditions for student learning (Cuban, 1986; Marshall, 2002; Reiser, 2001). Largely, research around the information learned from television lessons versus traditional instructional approaches found no substantive differences in the two. Much of this research found that instructional television occupied only a small niche of the school day and only a select and small group of teachers used the medium well (Cuban, 1986). As interest in the

television began to wane, the next technological innovation, the computer, had begun to catch the attention of educators and reformers (Marshall, 2002; Martin, 2014).

The computer revolution. While Computer-Assisted Instruction (CAI) and its prepackaged programed instruction had provided optimism two decades earlier before quickly fading, the rise of inexpensive desktop machines or personal computers created predictions of a new classroom revolution once again (Cuban, 1986; Marshall, 2002; Saettler, 2004). As Saettler (1979) stated, "Unfortunately, the claims of programmers far exceeded their skill and school storehouses began to be filled with unused machines" (p. 18). Though it appeared that computer-assisted-instruction would soon become another failed electronic technology in education, another form of computer appeared on the horizon with renewed enthusiasm… the personal computer (Cuban, 1986). Following IBM's introduction of its first personal computer in 1981, Time magazine christened The Computer as its 1982 "Man of the Year;" thus signifying the latest technological iteration and mania surrounding the "information revolution." The promise of personal computers or microcomputers in schools soon ensued, along with the much-anticipated impact on reforming education and classroom effectiveness. This hope fueled heavy investment in computers for classroom use as the number of computers increased sharply, with the numbers being drawn by surveys (Cuban, 1986). According to one survey by John Hopkins University researchers, by 1981-1982, five million students averaged nine hours each in front of a computer during a year, and by 1985, there were at least one million computers in American elementary and secondary schools (Becker, 1986). Despite this substantial outlay, computers in the classroom often went unused and seemed to have limited impact (Cuban, 1986; Cuban, 2003).

Surveys revealed that by 1995, the impact of computers on instructional practices was minimal, with substantial numbers of teachers reporting little or no use and computers being

used primarily for practice drills (Reiser, 2001). Although it seemed that personal computers were becoming another casualty in the educational technology cycle, things began to change in the mid-1990s. Good (2001) argued that, after decades of experimentation, educators were finally beginning to understand how to use technology as a tool in the classroom to meet educational goals. Rapid advances in digital technology and communication tools, most importantly, the Internet, led to a renewed interest in the computer as a medium for instructional purposes (Marshall, 2002; Kong et al., 2014). The Internet included email, search engines, and video on demand, while other newer digital technologies encompassed general productivity tools and Web 2.0 such as wikis, blogs, and social networks (Wurster, 2009). Many educators believed that in order to benefit from this new digital world, learners needed to develop inquiry, information, communication, and critical thinking skills to successfully acquire knowledge and process useful and reliable information from a variety of sources (Mouza, 2008). Using this type of technology would not only move instruction from a lecture-based model, but it would fundamentally change the way teachers teach and improved students learning experiences (Keengwe, Schnellert, & Mills, 2012). This required the development of fundamental skills in critical thinking, communication and collaboration with peers to analyze information and share results, which became known as 21st century skills (Kong et al., 2014; Penuel, 2006; Sauers & McLeod, 2012). Stone (2015) suggested that the need for a workforce with "21st Century Skill" was a clear public problem in the United States. Surveys indicated that high school graduates were deficient in most of the required 21st Century knowledge and skills needed for a successful career (Lowther, Inan, Ross, & Strahl, 2012). School systems felt that technology could transform the way student synthesized, produced, and shared knowledge (Superville, 2016).

Technology played an integral role in the development of these so-called 21st century skills, which included having access to a wider array of resources to support learning that allowed communication with peers and teachers as well as becoming fluent in the use of technology tools, and an ubiquitous computer had become the primary instructional platform and tool to further these new educational goals in developing digital classrooms of the future (Willocks & Redmond, 2014). By 2015, public schools were providing at least one computer for every five students and spending over $3 billion per year on digital content (Herold, 2015). Nonetheless, some felt that this was not enough, so in conjunction with this new emphasis on digital skills, a renewed emphasis on providing a personal laptop computer to every child was highlighted, and 1:1 computing ensued. The growth of these initiatives was fueled by widespread dissatisfaction with the status quo in education, although the use of technology in schools has had both strong support and opposition (Downes & Bishop, 2015; Zucker & Light, 2009). Further, the integration of these laptop programs was soon met with some familiar impediments and criticisms, including declarations that there was little proof that it was improving basic education (Richtel, 2011; Shapiro, 2014). Like other electronic technology initiatives before them, there were initial positive experiences and feedback with 1:1 computing initiatives, followed by a rapid discontentment leading some districts to drop this initiative (Hu, 2007; Swallow, 2015).

The history of technology in education seems to have been a series of trial and error as educators have enthusiastically embraced one iteration after another. One of first major electronic technologies that was promoted as a progressive teaching approach was the use of film in the classroom. Over the ensuing 20th century, an endless cycle of promising electronic technology ensued with the radio following visual instruction of film, followed by televisions in the

classroom, and then followed by the next technological innovation, the computer. Each promising educational technology fad introduced was often met with resistance, lack of training, high costs, and reliability concerns. As the new century dawned, rapid advances in digital technology, most importantly, the Internet, led to a renewed interest in the computer as a medium for instructional purposes and development of fundamental skills critical for this new world by providing each child with a personal laptop, and 1:1 computing ensued. Early indications have shown that 1:1 computing has had a positive impact on educational outcomes (Bebell & O'Dyer, 2010; Lei & Zhoa, 2008; Marshall, 2002).

1:1 Initiatives: Impact on Education

1:1 computing has been one of the most rapid, costly, and controversial initiatives in American education (Bebell & Kay, 2010; Lei & Zhoa, 2008). Over the past decade, the number of schools adopting 1:1 computing programs has increased considerably (Downes & Bishop, 2015). While the goals for laptop initiatives varied, most included increasing economic competitiveness, reducing economic inequities in computer access and information between socioeconomic classes, developing critical thinking as well as collaboration skills, and increasing student achievement (Bonifaz & Zucker, 2004; Thieman, 2015; Wagner, 2008; Zucker & Light, 2009). Further, proponents saw that this ubiquitous access to computing devices held great promise for personalized learning instruction and enriched curriculum (Downes & Bishop, 2015). Some of this pressure to change was driven by the No Child Left Behind (NCLB) Act, with its increased demand on school systems to provide every child with a high-quality education, and technology was seen as a way to positively impact the quality of education in all areas of K-12 as well as close the achievement gap (Mouza, 2008). Bonifaz and Zucker (2004) identi-

fied other factors to include improving classroom culture and discipline as well as increasing students' engagement. In the last decade, there had been a dramatic increase in the number and breadth of 1:1 initiatives as well as a considerable increase in the number of 1:1 evaluative studies, although research into the educational uses and student outcomes of these programs is still in its infancy (Lei & Zhoa, 2008; Mouza, 2008). Additionally, Lei and Zhoa (2008) found most of these studies had focused on two specific areas: implementation and impact of these initiatives. As Panuel (2006) described them, these reports were simply implementation studies. By its very definition, 1:1 computing denoted the level of access provided to each student, but it asserted nothing about changing the educational practices, which made these programs challenging to study and compare (Downes & Bishop, 2015). However, these studies, with the focus on a return on investment, mostly found a positive impact on student learning, including non-academic, and teaching outcomes in general (Lei & Zhoa, 2008). A comprehensive meta-analysis of the effect of 1:1 computing on academic achievement found significantly positive average effect sizes in several areas, including English, writing, mathematics, and science (Zheng, Warschauer, Lin, & Chang, 2016).

Academic achievement. While there have been some failures of 1:1 computer initiatives, there have been many more cases that supported the positive effects of these initiatives, including higher writing scores, science and math exam scores, literacy, higher order thinking, and grade point averages (Bebell, 2005; Gigliotti, Carrington, & Agostinho, 2013; Holcomb, 2009; Sauers & McLeod, 2012; Zheng, Warschauer, Lin, & Chang, 2016). As Holcomb (2009) stated, "the impact of 1:1 computer initiatives on student outcomes and measures has been examined and studied from several different angles" (p. 49). There has been little argument that 1:1 initiatives have the potential to have a significant impact on education, and there have been reports

from schools across the country that indicated improvements in student outcomes. In that regard, student academic achievement has been one of the most essential outcomes studied with regard to 1:1 computer initiatives, and the implementation of these initiatives was a significant influence on several areas related to the educational setting (Holcomb, 2009).

The area of writing skills was one of the most noteworthy areas where student achievement had been impacted by 1:1 computer initiatives (Downes & Bishop, 2015; Holcomb, 2009; Mouza, 2008; Zheng, Warschauer, Lin, & Chang, 2016). Holcomb (2009) found some of this could be attributed to the fact that students spent more time using their laptops to write, edit and reflect. In the state of Maine, where a 1:1 computer initiative was instituted statewide in their middle schools for five years, writing scores showed a significant increase on the Maine Educational Assessment (MEA) in 2005 (Silvernail & Gritter, 2007). The average student in 2005 scored better than two-thirds of the students just five years earlier. The positive impact and findings of Maine's 1:1 computer initiative on writing were clear, including students scoring better the more extensively they used their laptops to write and becoming better writers in general. Another review by the Metiri Group in 2006, which conducted an examination and analysis of 1:1 learning, found that students received considerably higher test scores and grades for writing (Holcomb, 2009).

Research has examined the effects of 1:1 computer initiatives on specific core content areas such as science and math, although the gains were not as significant as writing. Math scores have increased as a result of 1:1 learning (Holcomb, 2009; Mouza, 2008; Zheng, Warschauer, Lin, & Chang, 2016). One particular research study focused on the impact of the Maine Learning Technology Institute (MLTI) on enhancing science education (Berry & White, 2009). The

data gathered from this study suggested that students had higher levels of comprehension and retention when the assignment was technology-rich using laptops versus a standard paper report and diagram. Furthermore, it appeared that the students found the assignment more "fun" despite the fact that it took more time to complete than the traditional paper report and diagram. An examination of 7th grade school performance on ELA and Math indicated strong progress on a state assessment (Bebell & Kay, 2010). One potential explanation given was that students' participation in the 1:1 computer initiative found it to be more conducive and complementary to practices that fostered improvements in test performance.

Gigliotti, Carrington and Agostonho (2013) found that using laptops facilitated Higher Order Thinking (HOT), and as they pointed out "…the research found that HOT was evident in laptop tasks that allowed students to take an active role in the learning process and make decisions about how they would present their work" (p. 8). While the study was limited in terms of scale, as the study was comprised of just one primary school classroom, it was one of the first to examine if higher order thinking was evident.

Student achievement also appeared to be positively impacted by 1:1 computer initiatives (Bebell, 2005). Teachers generally reported an improvement in student achievement and better retention of learning. In a survey given to teachers, over 65% of the respondents felt that student achievement had improved (Bebell, 2005). Some studies have examined student achievement by comparing student GPAs before and after a 1:1 laptop initiative was implemented (Lei & Zhoa, 2008). This study found that student GPA increased over the academic year, although it was pointed out that it is unrealistic to expect dramatic changes in student performance through the use of a specific technology. While academic achievement is a difficult area in which to meas-

ure the impact of a 1:1 computer initiative, there are other areas that indicated a constructive impact in the educational setting (Bebell, 2005; Lei & Zhoa, 2008; Sauers & McLeod, 2012). The use of laptops not only produced some academic gains but it also improved student motivation and altered classroom interactions in non-academic ways (Mouza, 2008).

Non-academic. There have been other areas impacted by 1:1 computing initiatives in addition to student achievement, which fall into a number of categories (Sauers & McLeod, 2012) including student behavior, engagement, motivation, and equity of access to digital resources (Willocks & Redmond, 2014). Strong evidence from research suggested that these areas were dramatically impacted by 1:1 programs (Bebell & Kay, 2010; Mouza, 2008).

As one of the earliest and largest one-to-one initiatives, middle school students in Maine demonstrated fewer discipline referrals (Muir, Knezek, & Christensen, 2004). While some have predicted fewer student interactions due to 1:1 computers, classrooms activities increased in frequency and quality after the program was introduced (Bebell, Clarkson, & Burraston, 2014). Storz and Hoffman (2013) found that classrooms appeared quieter with fewer disruptions, although off-task behavior was more difficult to monitor. In general, students appeared better behaved. Their findings, which focused on student and teacher voices, established wide agreement that the classroom environment improved when the laptops were introduced. In another study, the initial findings of the immediate impact of a 1:1 computer initiative in New Hampshire found a decrease in disciplinary problems (Bebell, 2005). This program evaluation also found additional benefits of the 1:1 initiative, which were non-academic in nature.

Student engagement and motivation, which are fairly synonymous, have been positively impacted by 1:1 computer initiatives (Bebell, 2005; Muir et al., 2004; Keengwe, Schnellert, & Mills, 2012; Mouza, 2008). Mouza (2008) found that one important outcome of using laptops

was increased student motivation and determination in completing assignments, including taking the initiative to come up with their own classroom project using technology. Another aspect of engagement was the improved teacher-student and home-school communications that resulted with the introduction of ubiquitous technology (Zheng, Warschauer, Lin, & Chang, 2016). Students involved in Michigan's 1:1 computing initiative reported that laptops not only helped them learn more but also made them more interested in learning (Lowther et al., 2012). As one teacher commented (Downes & Bishop, 2015, p. 9),

> We're not just completing projects and then moving on to the next thing. The desire is that everybody has a role and purpose and is excited to come in so they can fulfill that role and its purpose. It's trying… to build self-esteem by purpose.

The results from a study into the impact of the Berkshire Wireless Learning Initiative (BWLI), a pilot program that provided 1:1 computers, found that student engagement increased dramatically (Bebell & Kay, 2010). This study also found that teachers overwhelmingly reported improvement in student engagement and motivation, although in some 1:1 computer configurations it can lead to an increase of off-task behaviors (Donovan & Green, 2010). In another example, teachers reported that students across all ability levels were more motivated, engaged and participated more when laptops were available. Stidham (2008) quoted one student who stated, "By making learning easier and fun, the laptop initiative has greatly increased my capacity and willingness to learn" (p. 54). In the study by Berry and White (2009), they found that students who integrated technology into a science classroom had higher levels of engagement, which mirrored their increased comprehension. Downes and Bishop (2015) found that not only was ready access to educational technology a crucial force in engagement but also inspiring to teachers.

Impact on teaching. Students are not the only ones who have benefited from 1:1 computer initiatives. These initiatives have allowed teachers to improve their teaching and instructional practices as well as proficiency in utilizing technology (Lee, Spikes, Wiebe, Hollebrands, & Young, 2015; Holcomb, 2009). The introduction of 1:1 computer initiatives placed additional demands on, as well as provided opportunities, for teachers (Storz & Hoffman, 2013). For example, Mouza (2008) found that teachers created more student-centered classrooms in 1:1 settings. Additionally, students regularly noted the significance of technology in providing more varied and engaging learning activities, including increased student-centered and individualized learning (Downes & Bishop, 2015; Zheng, Warschauer, Lin, & Chang, 2016). The technology not only enabled the use of innovative practices in instruction and delivery but a greater competence with this medium.

For teachers, one area that was impacted by 1:1 computer initiatives was their overall proficiency with technology as well as the increased usage of it (Bebell & O'Dwyer, 2010; Holcomb, 2009). In addition, teachers were also quick to integrate technology into their work both professionally and personally (Bebell, 2005; Ertmer & Ottenbreit-Leftwich, 2010). This increase in the use of technology included using it for planning and preparation, as an instructional tool in all areas of the curriculum, and requiring students to create products using the technology (Bebell & Kay, 2010). Further, the teachers that adopted technology into their instructional practices more readily were often the most comfortable with technology as well as placed a higher value on its use, although the data indicated that uses still tended to be traditional and teacher-directed (Ertmer & Ottenbeeit-Leftwich, 2010).

As far as teaching and instructional practices, there appeared to be movement away from the traditional paper and pencil activities as students had easier access to the Internet (Storz &

Hoffman, 2013). The inventory of teachers' instructional ideas was extended to include more group and individual work with students. Also, teachers required that students use computers more frequently to do Internet research as well as productivity computer tools. Bebell and O'Dwyer (2010) found that ubiquitous computing led to new forms of instruction, particularly computer-based tutoring systems. Additionally, students noted the significance of technology in contributing to a more relevant and engaging learning (Downes & Bishop, 2015). Another study by Bebell and Kay (2010) found fundamental changes in teaching, particularly teaching strategies, curriculum delivery, and classroom management. In general, teachers became emboldened to improve and augment their teaching and instructional practices through the use of technology (Holcomb, 2009).

The growing number of systems and schools that have adopted 1:1 computing has increased substantially in the last several years for a variety of educational purposes (Downes & Bishop, 2015). While this ubiquitous technology initiative has had its share of opposition and research has been limited, 1:1 computing has been positively linked to academic achievement, non-academic benefits, and changes in teaching pedagogy (Bebell & Kay, 2010; Downes & Bishop, 2015; Holcomb, 2009; Mouza, 2008). As with other predictions that technology will revolutionize teacher practices and student learning, there are signs that 1:1 computing initiatives are not living up to their advertised billing (Hu, 2007). With each new educational technology medium, several reoccurring barriers emerged such as poor implementation of such a massive initiative with little to no teacher input and training, underestimating the total cost to adequately support, and failing to create foundational and support in the schools and community (Saettler, 2004).

1:1 Computing Initiatives: Barriers to Sustainability

In 1989, the Methodist Ladies' College (MLC) in Melbourne, Australia became the first school to embark on supplying a personal laptop computer to every student on which they could work at school, at home, and across the curriculum (Stager, 1998). In effect, MLC became the first known case of 1:1 computing in the world. Since that time, 1:1 laptop initiatives have become widespread internationally and in the United States (Bebell & O'Dwyer, 2010; Gigliotti, Carrington, & Agostinho, 2013; Zucker & Hug, 2008). There was some initial solid evidence that 1:1 initiatives had a positive impact on educational outcomes (Bebell & O'Dyer, 2010; Richardson et al., 2013); however, several United States' school systems dropped these programs due to a lack of results, with some studies suggesting that the experiences of a 1:1 program have not been continuously positive, particularly the second year after implementation (Hu, 2007; Downes & Biship, 2010; Herold, 2015). Nonetheless, research offers little discussion about the impediments associated with implementing a 1:1 computing initiative (Fleischer, 2012), although many barriers have been identified (Keengwe, 2007). As Saettler (1979) said many years ago, "the potential of educational technology is revolutionary, but this potential is not likely to be realized in any reasonable time unless a number of serious problems are solved" (p. 24). These impediments resulted in unstructured and poorly maintained computer use that becomes a distraction to the learning and teaching (Clotfelter, Ladd, & Vigdor, 2009). As with any technology program, schools faced challenges and obstacles to sustain their plans over time once implemented (Campbell, 2015). While 1:1 computing initiatives have been seen by many as a catalyst in developing 21st century skills as well as transforming education, several barriers appear to be impeding their sustainability. The remainder of this section addresses common barriers to technology integration. Those barriers include the lack of long term funding and support, inadequate

teacher training and professional learning, shortage of technology leadership, failure to engage stakeholders and strategically plan, and unmet expectations.

Lack of long term funding and support. The long term funding and commitment needed when implementing a 1:1 computing initiative has often been overlooked and has long been an obstacle for these programs (Bonifaz & Zucker, 2004; Campbell, 2015). As Richtel (2011) stated, "schools are spending billions on technology" when budgets are being cut and teachers are being laid off. The resources needed for a 1:1 initiative go well beyond the device, and included providing the necessary digital tools and content as well the building and maintaining the necessary network infrastructure, which was difficult as state and local district budgets have taken many hits during the last several years (Bonifaz & Zucker, 2004; Stidham, 2008; Kiker, 2011). Therefore, elected officials and educational leaders must adopt comprehensive, strategic approaches to the capital replacement of technology and understand this was simply a recurring cost (Good, 2001). According to Kiker (2011), with creative planning and innovative design, a 1:1 computing model has been attainable, although many districts relied solely on grants to get started. Additionally, the use of technology enabled new savings through purposeful variations in school design (Simburg & Roza, 2012). However, an evaluation of the Texas Rural Technology (R-Tech) Pilot Program, which was authorized in 2007 to provide grants to support rural districts in implementing technology-based programs, found nearly half (48%) of principals reported that insufficient financial resources created a moderate or substantial barrier to continuing these programs (Maloney, Sheehan, & Rainey, 2010). While the resources needed to purchase devices and build a network could be formidable, many systems have had their 1:1 initiative negatively impacted by another resource, the lack of technical support.

Technical glitches and maintenance were another recurring issue with 1:1 laptop programs and initiatives (Stone, 2015). Schoepp (2005) identified the lack of technical support as a barrier to the integration of 1:1 computing initiatives in schools. Although districts continued to develop a strong infrastructure of hardware and connectivity, many continued to operate without sufficient technical support (Good, 2001). Having the school infrastructure to handle the hundreds of devices at any given time is important, and teachers listed connectivity as a reoccurring hindrance and a barrier (Minshew & Anderson, 2015). While Hu (2007) found that teachers felt pressure to use laptops, many simply stopped using them when the teachers found themselves taking too much time in dealing with technical issues. This led to laptops not only being rarely observed but to teachers reverting back to reading the text or writing on the board (Hu, 2007). Technical support was not only required for the computers but also printers, software and other components (Zucker & Light, 2009). While this has been a common concern with the introduction of each new educational technology, some reported being surprised at this development (Tusch, 2012). The general unreliability of computers required a lot of technical support (Walker, 2005). Additionally, many systems failed to provide support for other, minor logistical issues.

In addition to failing to provide adequate resources when implementing 1:1 computing, systems have often found their plans delayed or disrupted by minor, logistical details that were overlooked (Bonifaz & Zucker, 2004). This included making sure the mundane aspects of the initiative had been well thought out and supported, such as building the digital curriculum side, maintenance programs, upgrades, insurance and the cost of replacement equipment (Campbell, 2015; Lemke & Martin, 2004; Stidham, 2008; Tusch, 2012). Additionally, schools are required to develop strong use policies to deter inappropriate computing use during instruction (Keengwe

et al., 2012). Laptops needed to be protected from intentional and unintentional misuse, which not only required the development and establishment of a strong Code of Conduct, but the setting up of filters and other control mechanisms for laptops such as daily management tasks: inventorying, establishing a help desk, procedures for use, and redistribution (Bonifaz & Zucker, 2004; Campbell, 2015). In addition to the funding and resources needed to sustain 1:1 computing, Bonifaz and Zucker (2004) also found that training and professional learning was critical to the success of these programs.

Inadequate teacher training and professional learning. Bonifaz and Zucker (2004) stressed the importance of training and professional learning at different levels as an essential element of a successful 1:1 computing initiative. Despite this, a recent study found that teachers had concerns with their readiness and preparation in implementing 1:1 computing (Donovan & Green, 2010; Kline & Vriseno, 2015; Minshew & Anderson, 2015; Stone, 2015). These issues revolved around three primary areas: faculty readiness, faculty preparation, and faculty differences (Donovan & Green, 2010). There has been much evidence that erratic training has led to teachers who have been extremely slow to change the way they teach and embrace the student-centered, personalized learning instruction that 1-to-1 proponents imagined (Herold, 2015). Suffice it to say, a teacher's use of technology at the classroom level has played a key role in impacting how 1:1 computing initiatives are deployed and used (Bebell & O'Dwyer, 2010; Linton & Geddes, 2013; Mouza, 2008).

Appreciating faculty readiness to participate in a 1:1 computing initiative was vital, particularly against the backdrop of the perception that teacher education programs have not provided adequate training in the use of technology (Tusch, 2012). Ertmer and Ottenbreit-Leftwich

(2010) identified teacher education and knowledge as a critical factor in effective technology integration. Assumptions have consistently been made that undergraduate students and pre-service teachers learning in the modern technology era were highly competent in general computer skills and were more prepared to learn with technology as opposed to previous generations of students; however, today's students needed effective instructional use of technology for improved student learning (Bohach, 2015; Keengwe, 2007). While most teachers felt strongly about the possible benefits of 1:1 computing, nearly half those surveyed did not feel equipped to teach the students the skills required to use the devices (Hodgson, Hively, Tovar, Hauser, & DeVoogd, 2015). Opportunities for the faculty to discuss the technology innovation as well as address any misconceptions were important during the readiness phase, and further training and professional development could address these differences or concerns (Donovan & Green, 2010). Ridgway and Zhang (2015) found that experiencing a 1:1 technology approach benefited graduate level initial teacher candidates and also improved perceptions that the technology was favorably impacting their knowledge. Moreover, pre-service teachers needed to experience models of instruction that integrated their personal technical knowledge so they could become effective 21st century teachers (Bohach, 2015).

Providing faculty training and support before introducing a 1:1 computing initiative has been identified as another important area in gaining support for the use of technology in the classroom (Bonifaz & Zucker, 2004; Kiker, 2011; Yentes & Gaskill, 2015; Superville, 2016). Unless teachers were given the sufficient support and training to use technology proficiently as a teaching and learning tool, the potential benefits of the tool will not be achieved and new instructional practices will flounder (Good, 2001; Herold, 2015). However, helping teachers develop the skills required to properly utilize this technology and then recognize how their

instruction changes has proven to be a major barrier. Systems have consistently failed to provide adequate funding and support for faculty training (Good, 2001; Hodgson et al., 2015; Mouza, 2008). Jessica Heppen, a managing researcher at the American Institutes for Research, found support for technology integration was often diverted to the unexpected time that support staff had to spend on deployment and technical issues (Herold, 2015). Bebell & O'Dwyer (2010) and Herman (2015) found that professional learning was essential, and it should address teacher's beliefs about the type of instruction itself, not just how to use new devices and software. Further, teacher training on technology-based classroom management was seen as a proactive effort to limit negative faculty perception (Stone, 2015). The increased use of technology warranted the need of professional learning opportunities that were tailored to individual needs of teachers led by teachers (Linton & Geddes, 2013). Educators have valued a variety of training and professional development formats; however, the findings of R-Tech indicated that less than a quarter of surveyed teachers reported training was technology based (Bonifaz & Zucker, 2004; Maloney, Sheehan, & Rainey, 2010). Some districts have utilized "Academic Coaches" as a way to more directly individualize assisting teachers with the process of instruction (Hodgson et al., 2015). Regardless of the preparation of a faculty for a 1:1 initiative, faculty differences with technology innovation adoption were expected (Donovan & Green, 2010).

Differences within a faculty on their perceptions and training have been found particularly evident with the educational technology faculty and the non-technology faculty (Donovan & Green, 2010). The differences were often manifested in how the technology was implemented by individual faculty and understanding how faculty integrated technology into their teaching practices was found to be essential in helping to make informed decisions (Keengwe, 2007). The

expansion of technology in a system, with widely differing skill and comfort levels with technology integration, made it difficult to meet the needs of all teachers (Linton & Geddes, 2013). This highlights the importance of focusing on individual concerns in addition to whole-group concerns (Donovan & Green, 2010). Preparing teachers with effective professional learning in the use of technology should not be the only focus of faculty training, since administrators played a leading role not only in the implementation of a 1:1 initiative, but also in guidance and advice (Bonifaz & Zucker, 2004; Zucker & Light, 2009).

Shortage of technology leadership. Preparing school leaders who are equipped to lead changes in the way we teach and students learn, as required by our technology driven and global economy, required a focus on technology leadership (Bonifaz & Zucker, 2004; McLeod & Richardson, 2011). In the era of ubiquitous technology, administrators of K-12 schools played a pivotal and increasingly essential role as technology leaders; however, there were few mechanisms that prepared school leaders. (Dikkers, Hughes, & McLeod, 2005; Richardson & McLeod, 2011). Further, there was a shortage of coverage and limited research around this important aspect of school leadership and technology (McLeod & Richardson, 2011), although the level of technology leadership greatly impacted the quality of technology integration (Anderson & Dexter, 2005; Dexter, 2011).

Having strong leadership and preparing them to be technology leaders at all levels has been identified as another critical factor when implementing and leading the deep change required in a 1:1 computing initiative, particularly at the principal level (Bonifaz & Zucker, 2004; Ertmer et al., 2002; McLeod, Bathon, & Richardson, 2011; Pautz & Sadera, 2015). Only recently was there a focus on the role of leadership within a 1:1 environment, with the principal's leadership indicated as a significant factor influencing student outcomes in 1:1 schools (Greaves,

Hayes, Wilson, Gielniak, & Peterson, 2012). Further, technology leadership required leaders who understood the importance of technology outside of their school buildings, developed a strong forward-thinking vision that fit our technology suffused world, and recognized that the separation between man and machines will only increasingly narrow (Richardson, McLeod, & Sauers, 2015). Leaders also needed to consider the extraordinary scope and difficulty of undertaking a 1:1 computing initiative for teachers and students (Downes & Bishop, 2015).

Leadership preparation was divided into different domains, including using digital technologies, training school administrators to better use digital technologies, and, most importantly, preparing school administrators to be better technology leaders (McLeod et al., 2011). Technology leadership required tools to confront the unique challenges to integrating modern digital technologies, such as resistance from stakeholders, restrictive funding, and bureaucratic challenges (Richardson & McLeod, 2011). With the complexities of education today, leaders must focus on learning, particularly their own; therefore, the preparation of school leaders should require the development of the skills to continuously improve, reflect, and lead effectively (Richardson, 2014). It has also been shown that school leaders must understand the student population and configuration of the 1:1 initiative, so that students viewed the technology as a learning enhancement and teachers expected active student use (Donovan & Green, 2010). Pickert (2014) pointed out that a lack of leadership in understanding the complexity and preparation for a technology initiative, in one case not providing keyboards for a tablet despite spending more than $1 billion, brought down a sitting superintendent. At some schools, teachers have complained about a lack of administrative support, which is vital for such an expensive enterprise (Cromwell,

1999). Along with strong technology leadership, and before any system can undertake 1:1 computing, engaging stakeholders and developing strong relationships, including those outside of the system, were required for success.

Failure to engage stakeholders and strategically plan. As previously mentioned, 1:1 computing initiatives have been promoted as a remedy and solution for a multitude of objectives. In a rush to address these goals with a new, promising tool, systems have often neglected to plan adequately when implementing 1-to-1 computing initiatives, including aligning them with system goals, considering long term funding, and planning logistics carefully (Bonifax & Zucker, 2004). Bonifaz and Zucker (2004) indicated that successful technology integration begins with having a plan. Poor planning has led to districts having to pull back on their 1-to-1 efforts (Bushweller, 2015). Aligning a 1-to-1 computing initiative with a system's goals, vision, and mission has been seen not only as an important factor but also a starting point to the success of the plan (Hodgson, Tovar, Hively, Hauser, & DeVoogd, 2015).

Goal alignment, when implementing a 1:1 initiative, has been recognized as an essential factor in its success (Bonifaz & Zucker, 2004). The value of having clear expectations and outcomes was identified as a strong theme from interviews of several technology-astute superintendents (Richardson, McLeod, & Sauers, 2015), and it was imperative that schools first consider what the goals and expected impacts of the program would be (Bebell & Burraston, 2014). Additionally, having a vision and mission that directly tied into the 1:1 computing initiative was viewed as an important step in the implementation process (Hodgson, Tovar, Hively, Hauser, & DeVoogd, 2015; Zucker & Light, 2009). Leaders must understand their objective and what they hoped to accomplish through the use of technology in schools, such as delivering 21st century skills (Good, 2001; Kong et al., 2014). A coherent vision for how technology should be used in

the classroom, which is clearly articulated, was found to be critical to the success of using technology (Herman, 2015; Herold, 2015). Further, effective leadership planning should be collaborative, distributive, and a team effort (Hall & Hord, 2015; Richardson, McLeod, and Sauers, 2015; Superville, 2016). However, the lack of a strong implementation or integration plan has been found as a reason for sporadic use of laptops in 1:1 computing initiatives (Derndorfer, 2012). All stakeholders- comprising students, teachers, school leaders, and parents- must have an explicit understanding of what the community believes in teaching and learning through a process that included developing rules, embedding instructional design, engaging each member in the process, and generating feedback (Weston & Bain, 2010). Once a 1:1 computing initiative had begun, further planning, monitoring, and updating the plan was needed as it evolves over time (Hodgson et al., 2015). Along with having a vision and plan for using technology, and before any system can undertake 1:1 computing, a significant dynamic often overlooked with 1:1 computing initiatives has been developing solid relationships both inside and outside of the system (Bonifaz & Zucker, 2004).

Prior to the first laptop being handed out, certain conditions should have been put in place, including a philosophical foundation to gain buy-in from both the school and community as well as a technical foundation to provide a robust wireless network (Bonifaz & Zucker, 2004; Stidham, 2008; Stone, 2015). While fostering buy-in from all stakeholders has been shown to be critical in the integration of technology, maintaining participation from everyone was equally important to facilitate collaboration and identify emerging problems (Bonifaz & Zucker, 2004; Stone, 2015). Spending time with the community, developing their 1:1 knowledge and understanding levels, was seen as a crucial step in implementing this initiative along with allowing sufficient time for change and team building (Downes & Bishop, 2015; Hodgson et al., 2015;

Swallow, 2015). Parental involvement and community buy-in have been identified as two of the most critical catalysts for a 1:1 computing initiative (Stidham, 2008; Fleischer, 2012; Willocks & Redmond, 2014). Once these relationships and partnerships were developed, an ongoing engagement of stakeholders and communication was needed. This should have included developing partnerships and trainings with parents on basic technical skills, codes of conduct, and benefits of the initiative (Bonifaz & Zucker, 2004). Tusch (2012) found that once relationships had been developed and an ongoing partnership was established, parents and community members would be strong supporters who valued the educational experience students gained in 1:1 instruction, but this could take time. Unfortunately, the educational landscape is littered with examples of 1:1 initiatives failing to live up to high expectations when districts failed to connect the teaching and learning side with the technology side prior to implementation (Superville, 2016).

Unmet expectations. While 1:1 computing initiatives have been acclaimed as a way to offer all students and teachers continuous access to the Internet, software, documents and other digital resources for teaching and learning (Bonifaz & Zucker, 2004), other optimistic possibilities mentioned have included reducing inequities between the poor and wealthy, increasing economic competitiveness, solidifying home school connections, and raising student achievement (Bonifaz & Zucker, 2004; Zucker & Light, 2009). Maine's former Governor, Angus King, when proposing his state's laptop initiative that all seventh graders be given a laptop computer, confidently declared:

> For more than 100 years, Maine has always been in the bottom third of states - in prosperity, income, education, and opportunity for our kids. In my 30 years of working on Maine economic issues, no idea has had as much potential for leapfrogging the other

> states and putting Maine in a position of national leadership as this one – giving our students portable, Internet-ready computers as a basic tool for learning (Curtis, 2003).

While not specific to Governor King, Cuban (2001) claimed that promoters of electronic technology in education and some policy makers have often overrated computers. Lofty dreams of educational technology have often collided with reality when districts implement 1-to-1 initiatives and they failed to meet lofty expectations (Bushweller, 2015; Superville, 2016). Shapiro (2014) argued that we have gotten caught up in the trendy notion of educational technology without understanding its impact on the development of children.

As with the hyperbole throughout the evolution and history of electronic technology in the classroom, today's education prophets promote their forecasts about the emerging educational technologies as widely as ever. Whereas predictions about emerging technologies in education, such as 1:1, can play an important role in signaling new possibilities, lofty dreams of education technology have often collided with reality as unmet expectations and the feeling among educators that this is just another fad in a long line of many (Baggaley, 2013). Many of these huge promises about computers originated from the private sector, which often had a conflicting, self-serving interest (Walker, 2005). Some critics have asserted that schools are being motivated by blind faith in technology and an overemphasis in technology (Richtel, 2011). One superintendent, while he declared, "my gut is telling me we've had growth," went on to say, "we've jumped on bandwagons for different eras without knowing fully what we're doing. This might just be the new bandwagon" (Richtel, 2011, p. 3). The continuous abandoning of technologies that do the job well for promising yet unproven new technological mediums has set education

and students back over the years (Baggaley, 2013). This often created impediments and concerns from school faculty and staff. Further, the overselling of the impact of electronic technology does not often align with the reality that change takes time.

Allowing sufficient time for change and making it gradual has been found to be a critical aspect of the success of a technology initiative (Bonifaz & Zucker, 2004). All stakeholders should have been given the time to learn and become more comfortable with the new technology, which included teachers and students. Bebell & Kay (2010) reported that teachers, even after a couple of years using 1:1 computing in the classroom, felt they were just getting accustomed to the new setting. Further, Swallow (2015) found that it is important to understand the experience with 1:1 computing and technology initiatives in general on an incremental scale. When results were expected to be immediate, not only did some districts cancel their 1:1 programs due to a lack of immediate evidence of academic progress, moreover Hu (2007) found that even parents were critical of the laptop programs, with one parent stating she felt "ripped off."

While the integration of 1:1 computing in today's classroom has demonstrated some promising educational outcomes, it has encountered several impediments to its success (Bebell & O'Dyer, 2010; Keengwe, 2007). Some of the barriers with the implementation of a 1:1 computing initiative identified were the lack of long-term funding, inadequate teacher training, shortage of technology leadership, failure to engage stakeholders, and unmet expectations (Bonifaz & Zucker; Hodgson et al., 2015; Downes & Bishop, 2015; Donovan & Green, 2010; Stone, 2015). In Miami-Dade County, Florida, the school district slowed down an ambitious 1-to-1 computing initiative in order to observe and study what went wrong in other districts (Herman, 2015). Overcoming these barriers is critical to the successful implementation and integration of

a 1:1 computing initiative, and despite these impediments some public school leaders have been able to sustain this new educational tool.

Summary

This review of the literature provided an understanding of 1:1 computing and a framework for the study of 1:1 computing initiatives as it relates to sustainability as well as focused my research in that area. It narrowed what needed to be examined in this study, specifically the impediments to its success (Bebell & O'Dyer, 2010; Keengwe, 2007). The research also provided an understanding of the historical evolution of electronic technology in the classroom (Cuba, 1986; Kong et al., 2014; Saettler, 1979; Wurster, 2009). Further, the challenge for school leaders is understanding what factors influenced successful implementation and sustainment of 1:1 computing initiatives, particularly when several studies have found these initiatives have had a positive impact on education (Downes & Bishop, 2015; Lei & Zhoa, 2008). This study will inform policymakers, school leaders, and districts nationwide as to the key practices the helped in the successful implementation and sustainment of 1:1 computing initiatives.

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2 SUSTAINING 1:1 INITIATIVES: THE VOICES OF SUPERINTENDENTS

The purpose of this study was to examine the key factors that influenced implementing and sustaining 1:1 computing initiatives from the perspective of school leaders. This chapter includes the guiding research questions, significance of the study, theoretical framework, research design, participant selection criteria, data collection, data analysis, results, limitations, implications, and conclusion.

Drawing from the conceptual underpinning of constructivism and the literature highlighting the evolution of electronic technology, its impact on education, and the integration and impediments of 1:1 computing, responsive interviews of nine senior level public school leaders were conducted.

Purpose of the Study

There has been evidence that 1:1 computing initiatives have had a positive impact on educational outcomes (Bebell & O'Dyer, 2010; Richardson et al., 2013; Zheng, Warschauer, Lin, & Chang, 2016); however, some United States' school systems that adopted 1:1 computing programs are now discontinuing them due to a lack of educational results or failing to live up to lofty goals due to a disconnect between academics and technology (Hu, 2007; Superville, 2016). Bonifaz and Zucker (2004) found that each 1:1 computing initiative was unique and influenced by a number of factors. Moreover, they found leadership was the most significant factor that influenced these initiatives. As policy makers and school leaders decide whether to move forward with this expensive initiative, it is important for them to know what factors influenced leaders who were successful in implementing and sustaining 1:1 computing initiatives. Additionally, some have questioned the evidence that this initiative had improved basic

learning (Richtel, 2011), particularly in relation to the factors that influenced the effective implementation of these programs (Bebell & O'Dwyer, 2010; Keengwe, 2007; Paraskeva, Bouta, & Papagianni, 2006; Zucker & Light, 2009). Consequently, the purpose of this study was to understand the key factors that enabled the successful implementation and sustainment of 1:1 computing initiatives. The literature on 1:1 computing initiatives is limited, particularly on the factors that positively influenced the sustainability of these programs.

Guiding Questions

The following research questions were addressed in this study:

1. What factors did superintendents perceive to have influenced school districts as they made the decision to implement 1:1 computing initiatives?
2. What factors did superintendents perceive to have helped to sustain 1:1 computing initiatives?

Significance of the Study

This study was significant in many ways. Public school leaders need to make informed decisions when implementing a 1:1 computing initiative. By helping to understand the key factors needed to successfully sustain a 1:1 computing initiative, this study helps school leaders avoid the barriers of implementing and sustaining 1:1 computing initiatives. This study adds to the limited body of literature on 1:1 computing initiatives. As educational leaders make million dollar investments in educational technologies while struggling with limited resources (Bebell & Kay, 2010), it is imperative that public school system leaders learn from the experiences that have enabled the successful implementation and sustainment of 1:1 computing initiative.

Theoretical Framework

The guiding theoretical framework for this study is distributed leadership. Leadership has been found to be critical to the innovation of schools (Spillane et al., 2004), and the school improvement field has found that capacity building is critical to sustaining improvement initiatives (Fullan, 2001). Theories of distributed leadership provide a framework to pose questions and study the efforts of various stakeholders involved in leadership (Harris, 2008; Spillane, 2012; Spillane, Halverson, & Diamond, 2001). Gronn (2000) explained distributed leadership theory as leaders developing leadership in an organization, whether in individuals or in teams, in order to meet the increasing demands of education, specifically calls for continuous improvement. This definition closely aligns with this study, since systems and schools implemented 1:1 programs to meet this increased demand for continuous progress. Further, theories of distributed leadership highlight how leadership is spread throughout an organization, involves concerted and collaborative efforts by multiple stakeholders, and goes beyond task assignment to have a more profound collective impact (Gronn, 2009; Heikka, Waniganayake, & Hujala, 2013). Distributed leadership theory is at its core a theory of practice as viewed from both social and situational aspects, which offers a lens on leadership as it relates to the inner workings of a school system consisting of multiple stakeholders (Spillane, Halverson, & Diamond, 2001). Distributed leadership can help clarify the roles assumed by these senior level public school leaders, and how their actions, focuses, and leadership contributed to the successful implementation and sustainment of 1:1 computing (Spillane, 2012; Stoll et al., 2006). Consequently, a distributed perspective on leadership provides a framework for investigating leadership practice and how school leaders act as well as a means to reflect on and analyze their practice (Spillane et al., 2004). Dexter (2011) found that distributed leadership or a team-based leadership approach was particularly important

when implementing a complex, constantly changing technological improvement initiative, including 1:1 computing, to support teaching and learning. Consistent with distributed leadership theory, the key leadership activities investigated were the senior school leaders' interactions with a team of district, school and community members who collectively implemented and sustained 1:1 computing. Drawing from the theoretical framework of distributed leadership theory and the literature highlighting the history of technology, impact and impediments of sustaining 1:1 computing, I conducted a phenomenological study of nine superintendents on their practices and focuses as they reflected on and analyzed the factors and structures that either impeded or helped sustain 1:1 computing in their districts and schools. With this understanding of the theoretical framework of distributed leadership and research on 1:1 computing, the focus shifts to my own research study.

Methodology

This study employed a phenomenological design with qualitative methods of inquiry to explore the key factors that influenced implementing and sustaining of 1:1 computing initiatives, through in-depth interviews with superintendents, including one assistant superintendent. The basic purpose of phenomenology is to reduce individual experiences with an event to a description or a "grasp of the very nature of the thing" (Van Manen, 1990, p. 77). Phenomenology allows the researcher to focus on "the subjectivity of reality… on how humans view themselves and the world around them" (Willis, 2007, p. 53). This enables in-depth understanding of an experience or phenomenon in order to obtain comprehensive descriptions that provide the basis for a reflective structural analysis that portrays the essences of the experience (Moustakas, 1994). This study utilized the principles of phenomenological research in an attempt to interpret the per-

spectives of the public school leaders in response to one-to-one computing without any preconceived hypothesis or assumptions (Lester, 1999). Finally, this study pulled from the theoretical and conceptual foundation of constructivism, which holds that our reality is constructed by our individual, social, and historical setting (Genzuk, 2009).

The research was framed in a constructionist epistemological paradigm. Crotty (1998) stated that there is "no objective truth waiting for us to discover it," but rather it is constructed (p. 8). From this theoretical perspective, different people may construct meaning in different ways, even while experiencing the same phenomenon (Crotty, 1998). From this constructivist paradigm, individuals seek understanding of the world in which they live and work, through subjective meanings of their experiences, which is often combined with or called interpretivism (Creswell, 2007).

Research Design.

While the philosophical basis of the qualitative approach employed in this study was phenomenology, I framed this study utilizing an overarching constructivist or interpretivism theoretical perspective in designing this research. Interpretive research uses human interpretation to develop our knowledge of the world, which is heavily dependent on culture (Crotty, 1998). Through distinct "lenses," public school leaders would "view events, the expectations and meanings that they bring to a situation" in interpreting the key factors (Rubin & Rubin, 2012, p. 19). Interpretivism logically lends itself to "Responsive Interviewing" (Rubin & Rubin, 2012, p. 36). Therefore, I chose personal, responsive interviews as the method to collect data to attain a greater understanding of senior level public school leaders' perspectives of implementing and sustaining 1:1 computing initiatives (Rubin & Rubin, 2012).

This study utilized the principles of personal, responsive interviewing in an attempt to interpret the perspectives of system leaders in response to 1:1 computing without any preconceived hypothesis or assumptions (Lester, 1999, p. 1). It emphasizes the importance of "building a relationship of trust between the interviewer and interviewee that leads to a more give and take conversation" (Rubin & Rubin, 2012, p. 36). This interview model recognized that both the interviewer and interviewee could not separate themselves from the "feelings, personality, interests and experiences that shapes them as people" (Rubin & Rubin, 2012, p. 30). Research methodology focusing on voices has a long history, and this study is based on the premise that "voice be central in educational discourse" (Storz & Hoffman, 2013, p. 4). Responsive interviewing is an appropriate method for this study because it allows for an in-depth investigation of the key factors that have enabled the successful implementation and sustainment of 1:1 computing initiatives from the perspective of public system leaders despite challenges and barriers.

Participant Selection Criteria.

Because there is not an agreed-upon criteria or definition of districts that have sustained 1:1 computing initiatives, I chose a population of districts from a rural Midwestern state, Iowa, that has had a long history of 1:1 computing. While there have been states that have implemented 1:1 statewide, most notably the state of Maine, Iowa's fairly widespread use of 1:1 computing, over a third of the state's total, was the result of a grassroots movement (Richardson et al., 2013). Currently, approximately fifty-five percent of the systems in Iowa have indicated the implementation of 1:1 computing in their district (Iowa Area Education Agencies, 2016). Purposeful sampling was utilized to select individuals for the study because they were relevant and informed an understanding of the research problem and central phenomenon of this study (Creswell, 2007; Rubin & Rubin, 2012). For this study, I aimed to identify public school systems

that have implemented and sustained 1:1 computing initiatives. In this case, the initial selection process was conducted utilizing the state of Iowa's website database called 1:1: 21st Century Technology Learning Environments, which provides data on every 1:1 computing initiative reported by districts in this state, including the year of implementation (Iowa Area Education Agencies, 2016). After identifying one hundred and fifty-three such systems from this state, the study was narrowed through the use of criterion sampling.

Criterion sampling involves selecting all cases or sites that meet some predetermined criteria that are important to the study (Creswell, 2007). The criteria used in selecting school systems for this study included:

1. systems that had implemented a 1:1 computing initiative for four or more years;
2. each participant had to be in a senior leadership position during implementation; and
3. each participant also had to have three or more years' experience with the district.

In order to find systems that had implemented 1:1 computing initiatives for four or more years, the database allows the user to filter by implementation date. By selecting a date four years ago prior to beginning of this study, January 1, 2012, forty-eight school districts had an implementation date prior to that time. For this study, I believed that these districts represented a reasonable sample of districts that have implemented and sustained 1:1 computing initiatives because these districts had been able to sustain the initiative for longer than four years. Finally, each participant was required to be a superintendent and key player in the district's technology initiative, with three or more years of experience in the district. By selecting three or more years of experience with the district, this would allow the participant to have been a part of most if not all of the implementation and likely through a computer refresh cycle, which is commonly three years to avoid many costly repairs (Davis, 2010). These participants represented a reasonable sample of

individuals that have direct knowledge of the implementation and sustainment of 1:1 computing in their districts and schools, and consistent leadership support and administrative policy has been identified as an essential condition for these initiatives (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010; Bebell & Kay, 2010).

To recruit participants, I compiled the names and email addresses of each superintendent for each one of the forty-eight identified districts from the public Iowa 1:1 database as well as district websites. Recruitment of these forty-eight potential participants occurred through a series of several emails. For those superintendents who did not respond on the first attempt, I sent another email request. Out of the forty-eight potential superintendents, nine responded, met the selection criteria, and agreed to participate, which included one associate superintendent who substituted for the districts' current superintendent. The inclusion of one associate superintendent was made after determining that this individual met the selection criteria of being at the district for more than three years, was in a senior leadership position during implementation, and was recommended by the current superintendent to be interviewed in his place due to the fact that he was not at the district during implementation. Therefore, approximately 19% of the entire population participated in this study. It is unclear how many emails reached each of the forty-eight superintendents or how many also did not meet the selection criteria of having three or more years of experience with the district; consequently, the participation rate is likely much greater taking these factors into consideration. For the purpose of this study, these eight superintendents and one associate superintendent will be referred to more broadly as superintendents. The participants represented a key senior-level voice at the district level that had sustained 1:1 computing.

In order to maintain anonymity, the identity of all participants and school systems was masked; therefore, the names have been changed (see Figure 1). A description of the participants involved in this study, including their gender, race, years in education, and current position is included. The group of superintendents averaged just over 30 years in education and had a combined 273 years of experience in education. Further, a profile of each district that includes the enrollment data for each as well as the socio-economics is provided (see Figure 2).

Figure 1
Participant Profiles

Name	Gender	Race	Years Education	Highest Degree Attained	Position
Sandra	Female	White	28	Doctorate	Superintendent
David	Male	White	20	Specialist*	Superintendent
Russ	Male	White	34	Doctorate	Superintendent
Sam	Male	White	25	Specialist*	Superintendent
Dean	Male	White	23	Specialist*	Superintendent
Mira	Female	White	40	Doctorate	Superintendent
Michael	Male	White	36	Specialist*	Superintendent
Robert	Male	White	31	Specialist*	Superintendent
Charles	Male	White	36	Specialist*	Assoc. Superintendent

*Specialist or equivalent (A Master's degree plus at least thirty semester hours of planned graduate study in administration beyond the Master's degree).

Figure 2
System Profiles

Name	District Enroll*	District Socio Economics (Free or Reduced Lunch %)*
Sandra	1,706	30%
David	728	13%
Russ	1,620	30%
Sam	233	61%
Dean	1,104	37%
Mira	8,595	64%
Michael	354	40%
Robert	391	44%
Charles	6,747	18%

*Data retrieved from the Iowa Department of Education (www.educateiowa.gov)

Data Collection.

Personal interviews, for a phenomenological study, are an especially effective method for obtaining a special kind of information to gain another person's perspective (Merriam, 1998). Using the responsive interview model, intensive, 30 to 60 minute, semi-structured, open-ended telephone interviews were used to collect rich, thick descriptions that had depth and were nuanced to create "vivid thematic material" (Rubin & Rubin, 2012). For the purpose of this study, data were gathered through interviews with the superintendents. The interviews were conducted via telephone and recorded using a digital device for later listening and transcribing.

The semi-structured interviews were a mix of structured predetermined questions that were flexibly worded. This format allowed for new ideas about a topic to emerge and to obtain a special kind of information (Merriam, 1998; Rubin & Rubin, 2012). The intent of the interview questions with superintendents was to reflect on and gain an in-depth understanding of their experience in implementing and sustaining 1:1 computing. These interviews were structured around main questions in an interview guide that provided the scaffolding (Rubin & Rubin, 2012) for the interviews in order to ensure that the research question was answered (see Appendix A for interview guide). An interview guide is a list of main questions you intend to ask during the interview (Merriam, 1998), and I developed the initial set of questions after multiple reviews of the literature and research questions. Additionally, a draft of the interview questions was shared, via Google Docs, to a focus group of two practitioners and two experts in the field of educational technology and school leadership. Their feedback and comments were integrated into a final interview guide. Follow-up questions were also utilized to explore the interviewee's answers to obtain more depth and detail or to gain clarification, and probing questions were used to help manage the conversation (Rubin & Rubin, 2012). However, if the interviewee raised a

new topic or said something intriguing, the new material was immediately pursued as an extended conversation (Rubin & Rubin, 2012). Interviews were conducted over a six-week period from June to July 2016 and were scheduled at convenient times during the summer so as not to interfere with instructional time and other school events.

During the interviews, note taking allowed for the highlighting of elements for further questioning. The use of an interview protocol or predesigned form was used to record the information collected during the interview (Merriam, 1998). This enabled me to take notes during the interview and also helped me organize my thoughts on specific items. Both forms of data collection were utilized in this study.

Each interview was transcribed, coded, and analyzed. The interview protocol, notes, and transcripts from interviews will be kept for five years on a password-protected hard drive. Additionally, hard copies of documents were scanned in order for them to be stored electronically in portable document format (PDF). Electronic files were also saved on a flash drive, which was stored along the hard copies of documents in a locked file in my office. Only the researcher and administrative assistant have access to the files. Cross references to documentation were noted in interview transcripts.

Data Analysis.

Data analysis in qualitative research consists of organizing, classifying, and making sense of the data (Creswell, 2007; Merriam, 1998). Data analysis was conducted by coding general themes, searching for connections and relationships, and writing the narrative report. NVivo 10, a Computer Aided Qualitative Data Analysis Software (CAQDAS), was used to facilitate an in-depth analysis and coding. The software was used to disaggregate common themes and organize information to represent topics or patterns. The data was summarized, member checked, and

amended for accuracy and clarity. Understanding of the relationships and linkages between the themes enabled me to speculate on the inferences to address the research questions. As Moustakis (1994) described, "significant statements," sentences, or quotes that provide an understanding of how the participants experienced the phenomenon are highlighted, which is called horizontalization, followed by developing clusters of meanings from these statements into themes (p. 61). The audio-recorded interviews were transcribed to allow an in-depth analysis of the key factors that enabled the successful implementation and sustainment of 1:1 computing initiatives.

After the interviews were coded, I extracted all the excerpts that were coded with the same label or node from across all interviews into a single file using Nvivo in order to sort and summarize the content. After summarizing the content, the material was sorted within each file and the results were compared, which led to a set of related factors or themes that answered the research question (Rubin & Rubin, 2012). A theme captures a significant piece of the data in relation to the research questions as well as some level of pattern or meaning within the data (Braun & Clarke, 2006). Framing the data within the context and definition of this study assisted in discovering the essential themes that were relevant to the focus of the study.

To aid in trustworthiness, it is imperative that the researcher engages in self-reflection, throughout the process, in order to improve the interview quality and remain aware of personal perspective and possible bias throughout the interview process (Rubin & Rubin, 2012). Responsive interviewing allows for the interviewee to elaborate on his or her perspective without the interviewer's views or opinions influencing or guiding the responses (Rubin & Rubin, 2012). In a careful attempt to remove and address any bias, the final transcripts of each interview were shared and reviewed by all interview participants to ensure accuracy of reporting. Additionally,

the systemic documentation of material allowed for an independent audit trail of this study to draw conclusion and trustworthiness. References to literature and findings by other authors that confirm the inquiries interpretations were used to strengthen confirmability of the study. Each process in this study is reported in detail allowing for an external researcher to repeat the inquiry and achieve similar results, therefore, increasing dependability. Peer debriefing was also utilized to establish credibility, and "it is a process of exposing oneself to a disinterested peer in a manner paralleling an analytical sessions and for the purpose of exploring aspects of the inquiry that might otherwise remain implicit within the inquirer's mind" (Lincoln & Guba, 1985, p. 308). Through analytic probing, peer debriefing can help uncover personal biases, assumptions, and perspectives as well as provide an opportunity to test emergent data and analysis (Lincoln & Guba, 1985). Angen (2000) noted the importance of ethical and substantive validation of the research. Every effort was made to remain neutral and unbiased, and information was gathered as reported from the participants.

This study used a qualitative, phenomenological methodology to understand the perspective of system leaders on the key factors and activities as they implemented and sustained 1:1 computing. Further, this study utilized responsive interviewing to thoroughly explore and investigate these key factors, and is naturally suitable to the overarching theoretical perspective of constructivism or interpretivism. Through purposeful and criterion sampling, nine superintendents were identified, who represented a key voice in districts that had sustained 1:1 computing. After each interview was transcribed, data analysis was conducted by coding themes and searching for connections, which was aided by the use of NVivo 10 to provide in-depth analysis and organize the data. Several techniques were utilized to aid in trustworthiness to establish credibility and dependability in the results of this study.

Results

Analysis of the data revealed insights to some of the key factors that influenced the implementation and sustainment of 1:1 computing initiatives as well as some of the barriers and impediments for this initiative through the eyes of superintendents. This study was conducted with nine superintendents from across Iowa who met the selection criteria. These themes were then compared to research findings around the integration and obstacles of 1:1 computing initiatives. The information gathered through interviews and documents was reviewed carefully for alignment to previous studies. Five themes emerged after identifying and analyzing patterns in the data around the key factors that influenced implementing and sustaining of 1:1 computing. The first major theme is the importance of vision and planning prior to implementing this initiative. The second is how these system leaders used 1:1 computing to change teaching and learning. The third theme is the significance of considering resources, whether financial, physical, or human, when considering implementing and sustaining this initiative. The fourth is how these districts and system leaders embraced 1:1 computing for its ability to prepare students for today's technology suffused world. The final theme is equity and how these systems utilized this tool to create fairness and access for all students. The themes are listed in order from most coded references to least. The thematic analysis will provide a description of each theme, quotations of evidence, and concrete examples of actions taken.

Vision and planning.

A theme woven throughout the personal interviews with these superintendents was the importance of vision and planning when considering the implementation and sustaining of 1:1 computing. As the literature indicated, the emphasis on aligning a 1:1 computing initiative with a system's goals, vision, and mission has often been viewed as not only an important factor when

planning for this initiative but the starting point for its successful implementation (Hodgson, Tovar, Hively, Hauser, & DeVoogd, 2015; Superville, 2016). These superintendents indicated the planning for this initiative was accomplished by working together as a team and sharing leadership. Under the distributed leadership theory or conceptual model, research has found that effective leaders collaborated, and thus required a team effort to facilitate successful change, especially when implementing a complex technology initiative such as 1:1 computing to support teaching and learning (Dexter, 2011; Hall & Hord, 2015; Richardson, McLeod, & Sauers, 2015; Superville, 2016). A lack of alignment and planning with a district's vision can become a major barrier to sustainability. Through this study's personal interviews with these superintendents, it was clear that a great deal of strategic planning, which was collaborative and included shared leadership, had taken place prior to the first device being handed out.

These superintendents described the importance of strategic planning and working collaboratively to align their district's vision around any major initiative, particularly an expensive and complex technology initiative, like 1:1 computing, which would impact all facets of the district. As David said, "If it doesn't match your vision, and what you believe, and you don't have that, your own buy-in coming from your own admin(istrative) team and obviously then from your staff and community, it's not going to work." David described the use of teachers in utilizing 1:1 computing to further the district's vision. As he noted "We really try to push them to figure out what they need. You know, here's our goal, here is our vision, here is what we're going to do... figure out what you need to help us get there." While the implementation of 1:1 computing, for the superintendents interviewed, was seen as a way to further their district's vision in preparing students for today's world, their risk taking was purposeful, measured, and strategic. For these superintendents, with proper planning that was collaborative and included shared leadership, not

only can a 1:1 initiative support a district's vision and culture, but many impediments to sustainability could be avoided. As Dean stated, "one of the things that we're big on with initiatives, is we do… we're not the first ones to jump on board. There's the cutting edge and the bleeding edge. We like the cutting edge more than the bleeding edge." When Russ was asked about the sustainability of his district's 1:1, he stated that one of the primary factors was that "it was well planned out… and you have to be pretty strategic." Further, he noted, without proper planning to align 1:1 computing with a district's vision and culture, implementation and sustainability will suffer, "If that falls apart on you early, that will hinder the implementation." The actions of these districts, according to those interviewed, indicated using 1:1 to complement their vision through strategic, collaborative planning and shared leadership.

The superintendents shared evidence of their actions of intentionally aligning 1:1 computing with their vision through strategic, collaborative planning and shared leadership prior to its implementation. These districts had a history of collaborative planning and shared leadership, and 1:1 computing only enhanced this culture. As evidence of planning and shared leadership, these superintendents spent months and even years laying the groundwork prior to implementing 1:1 computing. This included building and developing technology leadership capacity, visiting 1:1 computing districts, collaborating with the community, conducting parent surveys, creating a computer refresh plan, developing guidelines for acceptable use, and providing professional learning to teachers and administrators. Further, these collaborative planning groups were comprised of various stakeholders, such as district technology and curriculum personnel, parents, community and business members, teachers, and administrators, which helped to promote and sell the 1:1 initiative. Charles noted that his district spent a good two years of planning for a 1:1 initiative, which included collaboration and shared leadership with the Chief Finance Officer,

technology department, teachers, and other staff. Also, many of the superintendents interviewed spoke of the support that they were provided with by their Area Education Agencies (AEA), which assisted with the planning and presentation of their 1:1 initiative. Mira described how her district utilized collaborative teams of teachers to think ahead in figuring out what the technology focuses would be for each grade level, which further enhanced their culture of shared leadership and ownership. The key, as many superintendents suggested, was asking how technology could help the district reach its vision of what they wanted students to do and learn. Additionally, many of those interviewed highlighted how 1:1 computing provided a collaboration platform. The actions of these districts indicate that strategic planning was utilized to collaboratively align with their vision and culture to support the implementation and sustainment of 1:1 computing.

Each of the superintendents in this study discussed the importance of vision and planning, through collaboration and shared leadership, when considering and supporting 1:1 computing. David succinctly summed this theme up when he stated, "if you don't have a clear vision of what you want a teacher to accomplish with it, you're going to struggle." For the districts represented by these superintendents, it was clear that 1:1 computing not only supported their vision but enhanced it through collaborative planning and shared leadership. This was a key factor that not only influencing their decision to implement this initiative but also sustain it.

Teaching and Learning.

The next theme that emerged throughout the personal interviews in this study was the strong belief by these system leaders that 1:1 computing would and had positively changed teaching and learning. These districts considered this a primary factor as they implemented this initiative; however, without the support and appropriate use by the teachers in the classroom sus-

tainability would not be possible. The literature indicated that the use of technology would fundamentally change the way teachers teach and improve the learning experiences of students (Keengwe, Schnellert & Mills, 2012). This included research that had also found that student engagement and motivation to be positively impacted by 1:1 computing initiatives (Bebell, 2005; Keengwe, Schnellert & Mills, 2012; Mouza, 2008). Changing the way in which students learn and teachers teach was a major consideration when implementing a 1:1 computing initiative.

For these superintendents, 1:1 became an important tool in profoundly changing the instructional experiences of students and practices of teachers. As Charles stated, "It had to do with changing how we instructed," when asked about the key factors his district considered when implementing 1:1. This sentiment was echoed by all of the superintendents, and as Robert noted, "I think it (1:1 computing) has provided more opportunities for teachers to teach differently." Sam stated, "I have teachers who tell me that 1:1 laptops have made me a better teacher." Sandra added, "I think it's great for our students and it opens up a whole other avenue of learning." She provided evidence of this when she noted, "I would say probably the thing that our kids are telling us that we need to improve upon, and this comes with everything, it's just being less teacher driven with instruction and more student driven and giving students more of the heavy lifting. And, the teaching and learning with technology could be a huge part of that." For David, the use of 1:1 to work together, personalize instruction, and receive immediate feedback stood out:

> the ability for kids to collaborate, not only internally with other students at a level that they had a hard time doing before, but externally, I mean, they're doing project with kids from other countries and other states and other school districts. And, when you see that happen and see what kids are able to create and develop...how they can push their own

> thinking, I mean it's just they're able to do things that you couldn't do without technology.

Robert also spoke of the benefit of 1:1 to aide with collaboration and produce authentic projects, "Those are the kind of things that changed the way students learn, the way teachers teach, and how we do business, as far as teaching and learning." For Dean, student engagement was found to be a major concern after looking at their data, and his district felt that 1:1 computing would improve upon it. He explained, "Nine years ago, when I got here, student engagement wasn't---we weren't happy with what we were seeing with student engagement and so we took the approach that we really firmly believe with the right instructional practices, implementing the tools of technology, that we could improve and enhance our student achievement. I think the data is showing that." These superintendents described the actions of their districts to purposely use 1:1 computing to substantially change the way teachers taught and students learned as well as their efforts to provide ongoing support to sustain this area.

Throughout these personal interviews, the actions of these districts clearly supported their emphasis on 1:1 to improve and change teaching and learning. These superintendents described how 1:1 computing provided numerous and unexpected benefits, which included but were not limited to the ability to move students through the curriculum and content utilizing dual platform classes and online courses, to release and give more responsibility to students, to provide responsive and on-demand professional learning, to collaborate internally and externally, to enhance curriculum development, and to utilize innovative instructional strategies. For example, a teacher in Dean's district who knew she'd be out for several days, flipped her classrooms by videotaping the lessons for each day, so when the substitute teacher came in, he or she was simply supporting the students. These districts found that 1:1 computing had afforded their students

with greater instructional opportunities, which had led to positive feedback from parents and students. The feedback was so positive and encouraging for Sandra's district that they are even considering allowing their devices to be checked out over the summer, so students could have access to their work. However, the use of 1:1 computing to change teaching and learning required ongoing professional learning and was an important consideration when implementing 1:1 computing, according to several superintendents. Without proper training and support, it could become a major barrier to sustainability. Like most of the system leaders interviewed, Charles noted that their training began prior to implementation and has continued with monthly release time that included administrators. The evidence provided from these interviews reflected the impact that 1:1 computing had on teaching and learning, which would not have been possible without this initiative.

For the superintendents in this study, the anticipated and actual impact that 1:1 computing had on teaching and learning was one of the most important factors in the implementation and sustainment of this initiative. Charles summed this up when he noted, "it's about how we fundamentally change learning and instruction." Also he added, "I think probably the other benefit is, we have teachers looking at education in a different manner." It was evident that in addition to dramatically changing the way their teachers taught these districts found that 1:1 computing had positively impacted the learning experiences of their students.

Resources.

Each of the superintendents interviewed in this study spoke about the importance of resources when considering implementing and sustaining a 1:1 computing initiative. Resources included financial, infrastructure, and personnel needs. The theme of resources was not only a key factor as their districts made the decision to implement a 1:1 computing, but also an ongoing

consideration in order to sustain the initiative. The long term commitment needed when implementing 1:1 computing has often been overlooked, which could make finances an impediment to successful implementation (Bonifaz & Zuker 2004; Campbell, 2015). This included building and maintaining the necessary network infrastructure as well as providing the necessary digital tools and content (Bonifaz & Zucker, 2004; Stidham, 2008; Kiker, 2011). The capital replacement and support of technology must be seen as a reoccurring cost; therefore, a comprehensive and strategic approach is needed by elected officials and educational leaders (Good, 2001). Based on the personal interviews for this study, the strategic consideration of the resources needed to support 1:1 computing was a major consideration when implementing a 1:1 computing initiative.

These superintendents understood the expensive nature of 1:1 computing, but found the benefits of this initiative too abundant not to find the resources to implement it. As Sam stated, "I mean we're a district that financially doesn't have a lot going but the one thing we want to provide is great opportunities for kids." Dean noted, "I think ultimately anything that's facing our schools right now in the state of Iowa has to deal with funding, and yet we have made that a priority. We have got some options on the funding side, but funding is extremely, probably the number one challenging piece." David described resources needed from the family and community's standpoint, "Honestly, a lot of it's to do with finances, can you afford it?" Sandra also echoed the importance of funding when implementing and sustaining 1:1 when she shared, "I think the biggest has been that we found a way to make it more financially powerful." Another area related to resources is building and supporting the appropriate infrastructure and personnel needed to implement 1:1 computing. In many cases, the financial commitment of these re-

sources toward building an infrastructure had begun well before any 1:1 initiatives were considered. As Charles stated, it "took multiple years. I don't remember what the budget was, but we're talking substantial budget there, and then we also as part of the 1:1 plan, we had to hire another technician." He also added:

> Probably the other thing that is behind the scenes, that the average person doesn't think about, is the technician support that keeps networks running, the stuff behind the scenes, when budgets are tight. That's probably the biggest challenge, is appropriately staffing behind the scenes support.

The actions of these districts indicated a commitment toward this initiative while strategically considering how to sustain the resources needed to sustain this initiative.

These personal interviews provided evidence that the actions of these districts supported their commitment of resources toward 1:1 computing. These superintendents described the importance of increasing bandwidth, placing and replacing wireless hotspots, upgrading security filters, and providing insurance for the devices, which takes financial, structural, and human resources. Many described the planning and preparation of preparing for a 1:1 initiative that was years in the making. This often included the implementation and installation of fiber between their buildings to handle the connectivity needed for the increased demand for digital data. In Charles's district, the installation of fiber, switches, and increased bandwidth began years before their 1:1 initiative. These districts also hired additional personnel skilled in technology, and these superintendents described the importance of adding the right people to their team as well as providing them time, training, and support to get up to speed. This allowed for the ability to look at what was working, what needed to be improved upon, apply for grants, and plan ahead for the ongoing financial and infrastructural resources. Mira described the great technology team she

worked with in her district that was instrumental in thinking ahead in searching for funding and studying the infrastructure needed to implement 1:1 computing. For many of these districts, the cost and consideration of devices was very important such as durability and price, although lately more affordable options had become available, particularly Chromebooks, as they refreshed their devices. Affordability and finances, according to David, was always at the forefront of any consideration for 1:1 for their families and community. For David's district, 1:1 computing matched their vision of what learning should look like, so they had to set up the resources to support it. While somewhat related to equity, Iowa fairly distributes a penny sales tax to all counties on a per pupil basis. Iowa's funding mechanism is called the Physical, Plant, and Equipment Levy (PPEL), and it was mentioned in every interview. These superintendents felt that not only was this an equitable means to distribute funds across the state, but also that the PPEL provided the resource for many districts to implement and most importantly sustain their 1:1 computing initiative. The actions of these districts supports their effective focus on resources when implementing and sustaining their 1:1 initiative.

Each of the superintendents in this study discussed the importance of resources, whether financial, physical, or human, when considering the implementation of 1:1 computing. Russ summed this theme up when he stated, "Technology is a black hole. You can pour as much money as you want into it and you are never going to fill it up. So, you have to be pretty strategic on where your dollars are going and how you're going to spend those dollars." While each noted the expense of 1:1 computing, these system leaders felt that the impact of 1:1 computing to support their vision made it a priority when allocating resources. The state of Iowa, with the

PPEL, has helped ensure equity across all areas of the state. While these superintendents describe resources as an ongoing challenge, it was clear that these districts had overcome this barrier.

Technology Suffused World.

Throughout the personal interviews with the superintendents, another theme that appeared regularly was the importance of embracing and recognizing today's technology suffused world when considering and sustaining 1:1 computing. During these interviews, the superintendents described a keen understanding of the importance and ubiquitous nature of technology outside of their school buildings, and as Richardson, McLeod and Sauers (2015) described, the separation between man and machines will only continue to decrease as technology advances and suffuses everything. For these superintendents, our technology suffused world required a digital platform such as 1:1 computing to facilitate and prepare students with the required skills to survive. The literature supported the importance of digital technology and the integral role it played in the development of skills such as critical thinking, communication, collaboration, and creativity, which have become known as 21st Century Skills (Kong, et al., 2014; Mouza, 2008; Penuel, 2006; Sauers & McLeod, 2012). Recognizing and embracing the importance of technology in our world today was a major consideration when implementing and sustaining a 1:1 computing initiative.

Many of the superintendents interviewed had a strong sense of how the increasingly digital world was a game changer for today's workforce and, as a result, the ever growing need for digital access and training. As Mira noted, "(technology) permeates everything." David also stated, "when we decided to go 1:1, there is this belief that if we were going to provide an education befitting of the 21st century, we needed to have tools that supported that type of learning.

So, we knew we needed devices. Specifically, we wanted to be thinking at the highest level." Sandra further reinforced this notion when she noted, "our big thing was the 21st century skills." Dean also spoke to this theme when he stated, "that was a driving factor and knowing that technology has just exploded in our society and in the work force and everything else. We needed to create those opportunities." Further, he added "Our kids deserve every opportunity in our educational setting to be prepared for the 21st century, and I think technology is huge." Michael seemed to speak for all the superintendents when he noted:

> there are very few jobs anymore, if you really pay attention to some of the meaningful careers out there, there's very few that someone's not interfacing with a technology of some sort, even if they're a machinist. And, so we're giving kids a 24-7 experience with technology at their will if they want to use it all day. And, I think that's very important for their futures.

Charles elaborated on a major benefit of 1:1 computing as a tool to prepared students for today's technology suffused environment when he stated, "one was just the availability of resources in the digital format, the ability to update resources and instructional practices to integrate what society is using so rapidly." The actions of these superintendents supported their recognition that their students lived in a technology suffused world, which was a primary factor when implementing and sustaining 1:1 computing.

These personal interviews provided evidence that the actions of these districts supported their commitment to preparing their students for today's digital environment with 1:1 computing. Toward this goal, 1:1 computing has provided numerous benefits that even exceeded the expectations of these districts as they took advantage of their devices in ways these districts never dreamed of. Sandra noted that when she speaks to recent high school graduates she continuously

hears how thankful they were that they were able to use technology in their courses. Some of the benefits of having a digital device for each student and teacher was the ability to collaborate immediately internally and externally, creatively change schedules, allow students and teachers to become experts, have resources in a digital format that could continuously be updated, and provide students with electronic textbooks. For most of the districts represented by these system leaders, they no longer have any paper textbooks, with everything becoming e-texts. In Russ' district, some parents balked at having e-textbooks at first; however, they began to embrace this digital format when textbook companies caught up with 1:1computing by adding online learning and built-in tutorials into the software. Instead of parents having to figure something out for their child, students could utilize this electronic tutorial and learning for assistance anytime. There were some additional barriers when it came to embracing technology for these districts. The superintendents pointed out their district's growing dependence on technology. Converting back to pre-digital methods and formats would almost be cost prohibitive. Further, the rapid and constantly changing nature of technology brought unexpected challenges such as trying to keep up with all of the latest technological applications as well as the almost overwhelming choices of digital resources. The actions of these districts supported their districts efforts to utilize 1:1 as a primary tool to prepare students for a world that was rapidly becoming more and more immersed in technology.

The personal interviews in this study found that these districts recognized the impact of today's technology suffused world on their students when implementing and sustaining 1:1 computing. This greatly influenced their decision to implement 1:1 computing to prepare students with the skills needed in today's digital environment as well as helped sustain this initiative as each district maximized the benefits of this digital tool. Charles summed up the sentiments of

most of the superintendents when he shared that his district was "not calling it so much 1:1 computing, as we are a digital learning environment. We try not to look at (1:1) necessarily always separate because it's so infused in everything. There's always the technology strand." While keeping up with the rapidly changing nature of technology was an ongoing challenge, it was clear that these districts had overcome this barrier by embracing the technology suffused world of today.

Equity.

The final theme that emerged throughout the personal interviews consistently was the strong notion of equity. Equity served as a major factor that influenced these superintendent's district's decision to implement 1:1 computing; however, it required constant consideration when implementing to avoid it becoming an impediment to sustainability. The literature tells us that the possibility that 1:1 computing could reduce inequities between poor and wealthy has been one of the more optimistic possibilities of this initiative (Bonifaz & Zucker, 2004; Zucker & Light, 2009). While the literature revealed that reducing inequities and increasing information between socioeconomic classes was one of several goals for 1:1 computing, the notion of equity was pervasive in these interviews.

These superintendents consistently expressed their views that 1:1 computing leveled the playing field for all students, which was a primary factor in implementing and sustaining this initiative. While Charles pointed out that his district was relatively affluent, he noted, "We also wanted to level the playing field…so, it had to do with equity." Without 1:1, he stated, students "wouldn't have access to those materials." Russ echoed the sentiments of the other superintendents concerning the importance of equity when he shared:

> The biggest issue, I saw it as an inequity issue, where kids that parents that have the means to purchase that technology and have that access at home and have internet available at home. Well, we have many students that do not have that access, that availability. So, more than anything in my eyes it was an issue of equity, the haves versus the have not's. I just didn't see that as being a level playing field for all the students."

Along the lines of equity was the pride that underprivileged students had for their device, which was noted by several superintendents. Sam noted:

> I can remember, especially some kids that came from pretty poor families. When they got, their own computers of course, …we told them, you protect your computer… one young man… was hanging on to it for dear life and he says there is nobody in my family who's going to touch this thing. He was so proud of it that, you know, that was great to see that the kids were that excited about something that. I'm sure that's probably the biggest and probably most prized possession that he probably ever received.

Russ further reinforced this positive aspect when he stated, "the have-nots, feel right now that they are one of the haves, because we're giving them something to use and to take home and we trust them with $700 - 800 piece of equipment. And we assign to him, and they take care of them. I mean, so I think that's pretty exciting. You hand a new laptop to a kid and say, now this is yours to use and take home and take care of, and they're like, 'wow'. You know again the equity issue, and all kids have the same opportunity." While equity and access to learning materials was available during the day through 1:1 computing, this would often end outside of the schoolhouse door, which could become a barrier to sustainability. As Mira shared, "we were sending them home, and we have the haves and the have nots." However, instead of remaining an impediment, it became a rallying point for the community as her district worked with partners

at the city level, philanthropists, and Google in developing a long-term project to provide free Wi-Fi throughout the entire city. She found this an extremely positive benefit, and as she added, "so I think one of the most wonderful things is that we really are trying together to solve that problem in our community so that we don't have the haves and have nots… and that would not have occurred without our 1:1 project. Nobody would even be thinking about it. So, that's really a remarkable, remarkable project that is directly tied to this." Sam also found equity as a possible barrier when he shared, "I think our biggest -- I mean we did have families that were saying, we're going to have to change our priorities a little bit maybe instead of some of the things that we were looking at possibly buying, we better make sure we have internet." Michael further spoke on the issue of equity as a possible barrier outside of the school due to a child's lack of access to the internet at home, when he noted, "we have to constantly remember, that there's at least 10% if not 20% that are going to go home with a computer that's relatively useless if we keep, base everything on internet-based web-based apps and tools and such." For his district, they worked to overcome this barrier by making some adjustments, "We made sure that kids that don't have internet access at home know to download what they need to have before they go home if they have homework and things like that, but that's a have and have nots kind of situation. The poor folks, or those who can't afford internet access, get left behind if we don't remember them specifically and we constantly stress that to the parent, to the teachers." While not a large population in Charles' district, he saw the benefit of 1:1 with the growing Hispanic population where English is a second language, when he shared, "So, if I'm student that just came here to the United States… I can use it to help me maybe use a translation app." The actions of these superintendents supports their strong belief in fairness when implementing and sustaining 1:1 computing.

These personal interviews provided evidence that the actions of these districts supported their goal to level the playing field with 1:1 computing. These superintendents noted the importance of using 1:1 to provide equal access to learning for all students, including immigrants where English is a second language, where the device could assist with translations. Sam noted that they had students sitting in the parking lot of an abandoned building on weekends or evenings just so they could have access to the free Wi-Fi from the library across the street. Like any new initiative, not every staff member embraced their districts move toward 1:1 computing. However, Russ found that the equity argument helped pave the way for some resistant teachers, who were on board with this initiative after considering this particular benefit of 1:1 computing. A strong belief in equity even extended to their discussions on funding at the state level. The words and actions of these districts backs their strong belief in fairness and equity, which was a primary factor when implementing and sustaining their 1:1 initiative.

Throughout the personal interviews, these superintendents consistently expressed their view that 1:1 computing leveled the playing field by providing digital access and increasing learning opportunities for all students. Russ seemed to speak for all of the superintendents when he powerfully rejoined, “I mean again it comes down to me, at the end of the day, it's an equity issue and if we’re anything about education, you have to support equity and every kid has an equal opportunity. So, if they don’t have that, then I think we’re just discriminating… in a roundabout way, I really do.” While these superintendents described equity as a major factor in their consideration to implement and sustain 1:1 computing, it was clear that these districts had worked hard to use their ubiquitous devices in ways that continued to promote fairness and social justice.

Limitations

While the research gave a voice to the perceptions and experiences of superintendents related to 1:1 computing initiatives, there were limitations of the study. First, the inquiry only considered superintendent's perceptions. The perceptions of school-level administrators, teachers, students, and community members were not included or discussed. Further, the study investigated the perceptions and experiences of superintendents in one state, Iowa. While the systems represented by these superintendents were representative of the state as a whole, the state was not representative of the national demographics. The data collected in this study applied to the perceptions of superintendents in one state and are not generalizable to other states. Therefore, the findings may or may not transfer to school systems in other states in the country.

A concern when using a qualitative research study design is research bias, and Merriam (1998) stated, "biases that cannot be controlled should be discussed." The preconceptions brought into this study by me center upon my own district's early implementation of a 1:1 computing initiative in a high school setting. I have worked in the public school setting for over twenty years as a teacher, principal, and currently a senior-level school system administrator. Further, I hold strong beliefs that with proper planning, training and support 1:1 computing initiatives can be effective and sustained. In stating this bias, it is my hope that the reader will have a better understanding of the personal philosophies guiding this study.

Implications.

Through this study, the perceptions of these superintendents provided a unique window into what it took to successfully implement and sustain a 1:1 computing initiative. The results from this study indicate that several key factors helped to sustain 1:1 computing, which have implications for both policy and practice. Each of the key themes discussed in this study play an

important role in implementing and sustaining 1:1 computing. These themes were vision and planning, teaching and learning, resources, technology suffused world, and equity. The practical implications of each of these themes, as well as some additional findings, are discussed as they pertain to policymakers and system leaders. As an important note, the impact on academic achievement was not a primary factor identified in this study that influenced these districts when implementing 1:1 computing. In essence, the factors identified in this study were so important to these superintendents, regardless of any identified impact on academic achievement, that implementing 1:1 computing was a worthwhile and essential initiative.

Implications for policymakers and system leaders.

This study contributes to the existing literature on 1:1 computing and sustainability. Further, this study revealed findings that have implications for policymakers and system leaders as they consider implementation of 1:1 computing as well as sustaining this initiative. When implementing 1:1 computing, policymakers and system leaders need to make informed decisions and utilize strategic planning. This research has the potential to provide a deeper understanding of the key factors needed to implement and sustain a 1:1 computing initiative, which should help policymakers and system leaders avoid the barriers to sustaining this impactful initiative. As these policymakers and system leaders make decisions on investing in an expensive initiative such as 1:1 computing with finite resources (Bebell & Kay, 2010), it is imperative that they learn from the experiences that have enabled the successful implementation and sustainment of this initiative. This section begins with the practical implications of each of the five themes for policymakers and system leaders as they consider implementing and sustaining a 1:1 computing initiative.

Practical implications. For policymakers and system leaders considering 1:1 computing, vision and planning should be key elements when considering the implementation and sustainment of 1:1 computing. The aligning of 1:1 computing with a district's goals, vision, and mission has been viewed as the starting point for successful implementation (Hodgson, Tovar, Hively, Hauser, & DeVoogd, 2015; Superville, 2016). This research affirms how important having a vision is; however, this takes thoughtful planning well before the first device is handed out. Further, this study indicates that the strategic planning for this initiative should be collaborative and shared. Policymakers and system leaders that rush to implement 1:1 computing without considering its alignment with the system's vision or allowing for collaborative planning are potentially creating a major impediment to sustaining this initiative.

This work indicates that a system's use of 1:1 computing to comprehensively change teaching and learning should be a focus for policymakers and system leaders when implementing this initiative. Technology can fundamentally change the way teachers teach and improve the learning experiences for students (Bebell, 2005; Keengwe, Schnellert & Mills, 2012; Mouza). This study affirms how important it is to fully utilize and emphasize 1:1 computing in changing teaching and learning. Further, the results indicate that 1:1 has numerous and some unexpected benefits in this area, but this takes on-going support and training. Without this support for teachers, students, and administrators, which should occur prior to implementation as well as on an on-going basis, policymakers and system leaders could be creating a substantial barrier to the sustainment of this initiative.

For policymakers and system leaders, a strong focus on resources should be imperative when considering the implementation and sustainment of 1:1 computing. Resources include financial, infrastructure, and personnel needs; however, these important commitments are often

overlooked with this expensive initiative (Bonifaz & Zucker, 2004; Campbell, 2015). This research affirms how important the commitment and planning for resources was when considering 1:1 computing as well as sustaining it. Further, this study indicates that this commitment extends to other areas often unseen, such as having a robust infrastructure, and takes months and sometimes years of preparation. Policymakers and system leaders that implement 1:1 computing without considering its long-term and reoccurring financial commitment of resources can create a significant obstacle to sustaining this initiative.

This work indicates that embracing and understanding the importance of technology in today's digital world should be a primary focus for policymakers and system leaders when implementing this initiative. 1:1 computing provides a digital platform that helps to prepare students with important skills to thrive in this technology suffused environment such as critical thinking, communication, collaboration, and creativity, which have been called 21st Century skills (Kong, et al., 2014; Mouza, 2008; Penuel, 2006; Sauers & McLeod, 2012). This study affirms how important 1:1 computing can be in preparing students for today's technology suffused world. Further, the findings indicate that organizations, which supported and recognized how today's digital environment impacts students, found that 1:1 computing was a crucial tool. Without embracing and understanding the role of 1:1 computing in preparing students for today's technology world, policymakers and system leaders could be creating an impediment to the sustainment of this initiative.

For policymakers and system leaders considering 1:1 computing, equity should be a key element when considering the implementation and sustainment of 1:1 computing. 1:1 computing provides an opportunity to reduce inequities between poor and wealthy students (Bonifaz & Zucker, 2004; Zucker & Light, 2009). This research affirms how important 1:1 computing was

in leveling the playing field and addressing the equity issue. Further, this study indicates that 1:1 computing provides equal access to learning for all students regardless of socioeconomic status. Policymakers and system leaders should make equity a primary consideration when implementing and sustaining 1:1 computing in ensuring access to materials extends beyond the school building, including Internet access, or this factor could become a barrier to sustainability.

General implications. The implications above were all directly related to policymakers and system leaders that were considering implementing 1:1 computing and how to sustain this initiative. The implications, however, are meaningful for policymakers and system leaders that are not considering this particular initiative. While a major technology initiative is unique in some ways, these key themes or factors are not exclusive to implementing and sustaining 1:1 computing. For any major initiative, the key factors of vision and planning, teaching and learning, and resources are critical components in implementation and sustainment.

The study findings also support and extend previous research on the effectiveness of distributed and technology leadership (Gronn, 2009; Hall & Hord, 2015; Heikka, Waniganayake, & Hujala, 2013; Richardson, McLeod, & Sauers, 2015). As Dexter (2011) reported, a distributed leadership or team-based approach is particularly important when implementing a complex technology improvement effort to support teaching and learning. Further, it requires a keen understanding and vision of how technology impacts all facets of the district from infrastructure to policies and practices. As Richardson, McLeod, and Sauers (2015) found, this requires a technology savvy leader that strongly supports collaborative efforts, embraces innovation, is a bit of a risk-taker, and continuously works to continue their learning. This research found many examples of distributed and technology leadership as these superintendents were able to harness the

potential of 1:1 computing to prepare students for today's technology suffused world, improve academic achievement, and change the way teachers teach and students learn.

The words and actions of these superintendents indicated a strong connection with distributed leadership. Consistently throughout the personal interviews, these superintendents used words like "collaborative" and "team." Congruent with distributed leadership, these superintendents described cooperative activities and interactions with multiple stakeholders, including school and community members, who were involved in the implementation and sustainment of 1:1 computing. Further, many expressed that others in their system were instrumental in leading and assisting with this initiative. Mira, when discussing her work with the director of technology, described the team he assembled as a "great lead team, and they did a fabulous job of thinking ahead, figuring things out." The implementation and sustainment of 1:1 computing centered on cultures that valued leadership that was spread throughout the organization, including teacher-leaders. Dean described this point when he shared, "you're going to take your high flyers right away and you're going to get going and it's just going to build from there." Charles discussed the importance of "teachers that were technology leaders" and how critical they were not only in the planning of this initiative but in sustaining it. Finally, a distributive leadership or team-based approach, while most evident in the vision and planning theme, was interwoven throughout each of the other key themes discussed as an integral part of the implementation and sustainment of 1:1 computing.

Conclusion

Since being introduced in the late 1990's, 1:1 computing has been one of the fastest growing, most debated, and most expensive technology initiatives in American education (Bebell & Kay, 2010; Herold, 2016; Lei & Zhoa, 2008; Storz & Hoffman, 2013; Zucker & Light, 2009).

During 2013 and 2014, more than 23 million devices were purchased by schools for use by teachers and students, which included laptops and tablets (Herold, 2016). Despite research that 1:1 computing had a positive impact on educational outcomes, there have been a handful of prominent 1:1 implementation failures, with several school systems around the United States discontinuing these initiatives as well as some skepticism about the impact of educational technology in general (Herold, 2016; Hu, 2007; Zheng et al., 2016). While each 1:1 initiative was unique, leadership was found to be the most significant factor in its implementation (Bonifaz and Zucker, 2004). As more policy makers and public school leaders decide whether to move forward with this expensive initiative, it is important for them to know what factors influenced leaders who were successful in implementing and sustaining 1:1 computing initiatives. This study examined and identified several key factors, through personal interview of superintendents, that enabled the successful implementation and sustainment of 1:1 computing initiatives. While summarized separately, each one of these themes is interwoven with the others, building a foundation for success and sustainability.

These superintendents described the importance of vision and planning, through collaboration and shared leadership, when considering and supporting 1:1 computing. By strategically planning and collaborating, these districts were able to align 1:1 computing with their vision of teaching and student learning, which was a key factor in the implementation and sustainment of their initiative.

These superintendents also described the importance of utilizing 1:1 computing to dramatically change teaching and learning. By using 1:1 computing to fundamentally change the way teachers taught and students learned, these districts were able to increase student motivation,

personalize instruction, and improve instructional practices, which was a key factor when implementing and sustaining this initiative.

Additionally, these superintendents described the importance of considering and planning for the resources needed when implementing and sustaining 1:1 computing. By understanding the upfront and ongoing costs associated with 1:1 computing, whether financial, physical, or human, these districts were able to provide their teachers and students with the support needed to have functioning and effective devices, which was a key factor in the implementation and sustainment of their initiative.

Further, these superintendents described the importance of recognizing and embracing today's technology suffused world when implementing and sustaining 1:1 computing. By recognizing the rapidly growing digital world that today's students live in, these districts were able to utilize 1:1 computing as a tool to provide the skills to navigate this environment, which was a key factor in the implementation and sustainment of their initiative.

Finally, these superintendents described the importance of equity, or leveling the playing field for all students, particularly for poorer students as their districts implemented and sustained 1:1 computing. By considering and utilizing 1:1 computing to reduce inequities between poor and wealthy students, these districts were able to provide equal access to information and materials, which was a key factor in the implementation and sustainment of their initiative.

This study found that these districts strategically and thoughtfully considered these key factors when implementing and sustaining 1:1 computing. Sustainability was at the forefront of their planning, and as Dean noted, "If we cannot sustain a program and it's not viable, we will not implement." By combining and considering these key factors, these superintendents were not only able to implement and sustain their 1:1 initiative, but also create an indispensable tool

that most couldn't imagine not having. As Sam stated, "I just don't think dropping it would be even acceptable."

The cyclical nature of technology and the emphasis on using technology to profoundly change education has been criticized (Cuban, 1986; Cuban, 2003). Cuban (2003) described the limited impact of earlier technologies such as radio, film, and televisions on education, to predict that computers would suffer the same fate with over exaggerated predictions, unfulfilled promises, and little if any results. Others, however, believed that the ability of computers to meaningfully change learning and access information made it radically different from these earlier iterations of educational technology; therefore, these devices would have a very different impact on education (Zheng, et al., 2016). It was clear from the words of these superintendents that, by considering certain key factors when implementing and sustaining 1:1 computing, the promise of computers to significantly and positively impact education in their districts was not only possible but also exceeded their highest expectations. Martha powerfully summarized the essential and crucial tool that 1:1 had become for her district, "We believe in it. We believe it's the future. We believe it keeps us on our toes. It helps us modernize what learning we're giving kids, and I don't think we would ever have spent this much time and energy and money, if we were not going to continue it. I can't imagine dropping it."

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APPENDICES

Appendix A

Opening

[Participant name],

Thank you so much for agreeing to speak with me at this time. I know you have an extremely busy schedule and I appreciate your willingness to participate in this important project.

I have several main questions to ask you today. As we talk, I may think of follow-up questions as well. If at any time you do not wish to answer a question, or would like to end the interview, please let me know. I anticipate that our conversation will take 30-45 minutes.

1. As we get started here, would you confirm orally that you received the consent form that was sent to you and that you also recognize that this interview will be recorded? [pause] Thank you.

Main Interview

<u>Background Questions</u>

2. How many years have you been in education?
3. What different roles have you served?
4. What is your educational background?
5. What are the demographics of your district?
    - Number of students?
    - Diversity of your district?
    - What is the socioeconomic status of your district?

Implementation Questions

6. What influenced your district in the decision to implement a 1:1 computing initiative? What were the specific factors? [ask follow-up probes about any/all of the items below as necessary]
    - 21st century skills?
    - Research based decision?
    - Most important factor?
7. Who was involved in the planning and implementation of your system's 1:1?
    - What role did you play?
    - What role did each person play?
    - Why did you invite this set of players to the table?
8. What was the initial reaction to this initiative from stakeholders? How did you ensure there was buy-in?
    - What 1:1 model did you use (all at once/roll out/2:1/BYOD)?
    - Community?
    - Schools
    - Students?
9. How did you plan for technical support and infrastructure for 1:1?
    - What were your plans?
    - Was any thought given to student negligence (with hardware)?
    - Other technology tools/support (tracking, asset management, outside support)?
10. How did you fund your 1:1 initiative?
    - How do you plan to continue to financially support 1:1?

11. Did your district conduct training and professional learning *prior to* the implementation of 1:1? Let's start with teachers. What professional learning did you provide them?
    - Alright, what about administrators? What training did you provide them?
    - Support staff? Tech team?
    - Anyone else provided with professional learning?
    - What about *during* implementation?
    - Or *after* implementation?
    - Was it the same for everyone?
    - What kinds of professional learning do you think is or was most effective when it comes to 1:1 computing? For who?
12. Were there any unexpected problems during the implementation of 1:1?

<u>Sustainability Questions</u>

13. What are some of the positive outcomes or benefits of your 1:1 implementation? [ask follow-up probes about any/all of the items below as necessary]
    a. Schools?
    b. Students?
    c. Leaders?
    d. Teaching and Learning?
    e. Outcomes?
    f. Other?
14. From your perspective, what are the major barriers to the successful implementation 1:1? [ask follow-up probes about any/all of the items below as necessary]
    a. Unmet expectations?

b. Planning? Funding?

c. Leadership issues?

d. Training and professional learning?

e. Technical issues?

f. Culture or climate?

15. Several districts have dropped 1:1 for a variety of reasons. Why do you think your district been able to sustain this initiative (i.e. detailed planning, stakeholder involvement, professional learning)?

16. Here's the next-to-last questions: What challenges does your district still face in sustaining 1:1 computing in the future?

Conclusion Questions

17. Thank you so much. Is there anything else you want to to say on the topic of 1:1 computing and sustainability? Anything that I should have discussed but didn't?

Wrap up

Okay, that's it! I appreciate your time today. After I look over the transcript of our conversation, may I contact you if I have further questions?

Thank you. If you have any further questions for me, please do not hesitate to contact me at any time. Do you have my contact information?

Excellent. Thank you so much for participating in this interview. Have a great day!