Ubiquitous Computing in Schools: A Multi-Case Study of 1:1 Districts

A Capstone Project from the
Virginia Commonwealth University
School of Education

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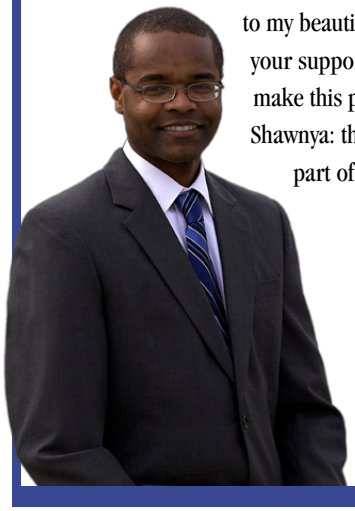
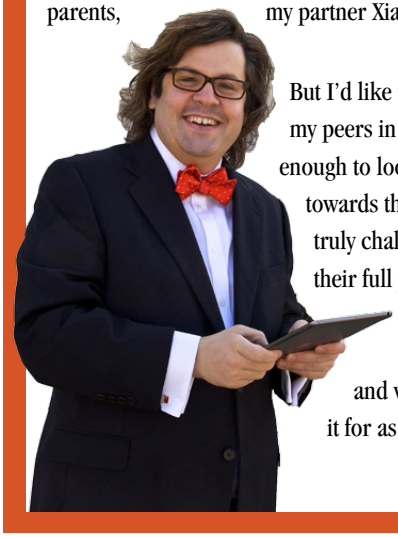
Dedication

Our doctoral program was dedicated to the concept of leadership. As it turns out, the biggest theme to emerge in the creation of one-to-one projects is leadership. We dedicate this work to the future leaders we have helped cultivate in our schools. We will be fortunate if they can take us into new directions.

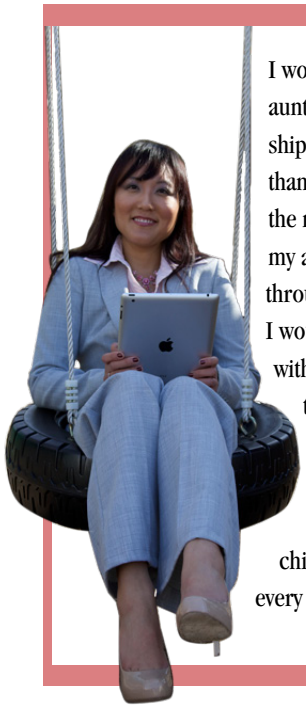
During this three-year journey there were many days where I needed a helping hand to keep me going. There was always one person who never doubted my abilities and believed that I would be successful throughout my career. I dedicate this to my beautiful wife Giang. Thank you for your support and everything you did to make this possible. To Angie, John, and Shawnya: thanks for allowing me to be a part of the team.



I have too many people to thank for contributing to my leadership, not to mention looking after me through the process of co-writing and conducting this research. Among them are my parents, my partner Xiaobing, and my friends.



But I'd like to dedicate this work to my peers in the field who are brave enough to look beyond the horizon towards the possibilities when we're truly challenging children to realize their full potential. I've been lucky enough to see constructionist education in action and will continue to champion it for as long as I'm an educator.



I would like to thank my parents, brother, aunt, and my mentor who saw my leadership potential early in my career. I am also thankful to have a wonderful best friend, the most supportive group of friends, and my anchor who has kept me grounded through the past few intense months. Also, I would not have grown as a researcher without the supportive criticism of my teammates.

My dedication also extends to all of the educators whose passion and love for children drive their vision and leadership every day.

God has blessed me! Over my life, those who modeled amazing leadership and those who saw leadership potential in me have encouraged me. This capstone dissertation is dedicated to them along with my loving and supportive husband (Linze) and children (Linze & Shawn); my mom who is my rock; my dad and cousin who are my encouragers; my sisters & brother; my mother-in-law, step-mother, & grand- mother; and my "sister friends" who always have my back. And to the memory of an amazing, inspirational instructional leader who was willing to take risks to do what was best for children, Dr. Christopher Corallo.

"The way to be first, therefore, is not to play catch-up, but to take the lead in new directions."

— Seymour Papert (1993), *The Children's Machine*. New York: Basic Books

The research undertaken in this study was approved by the Virginia Commonwealth University Internal Review Board.

Our thanks go to our advisory team Dr. Charol Shakeshaft, Dr. Jonathan Becker, and Dr. James Lane.

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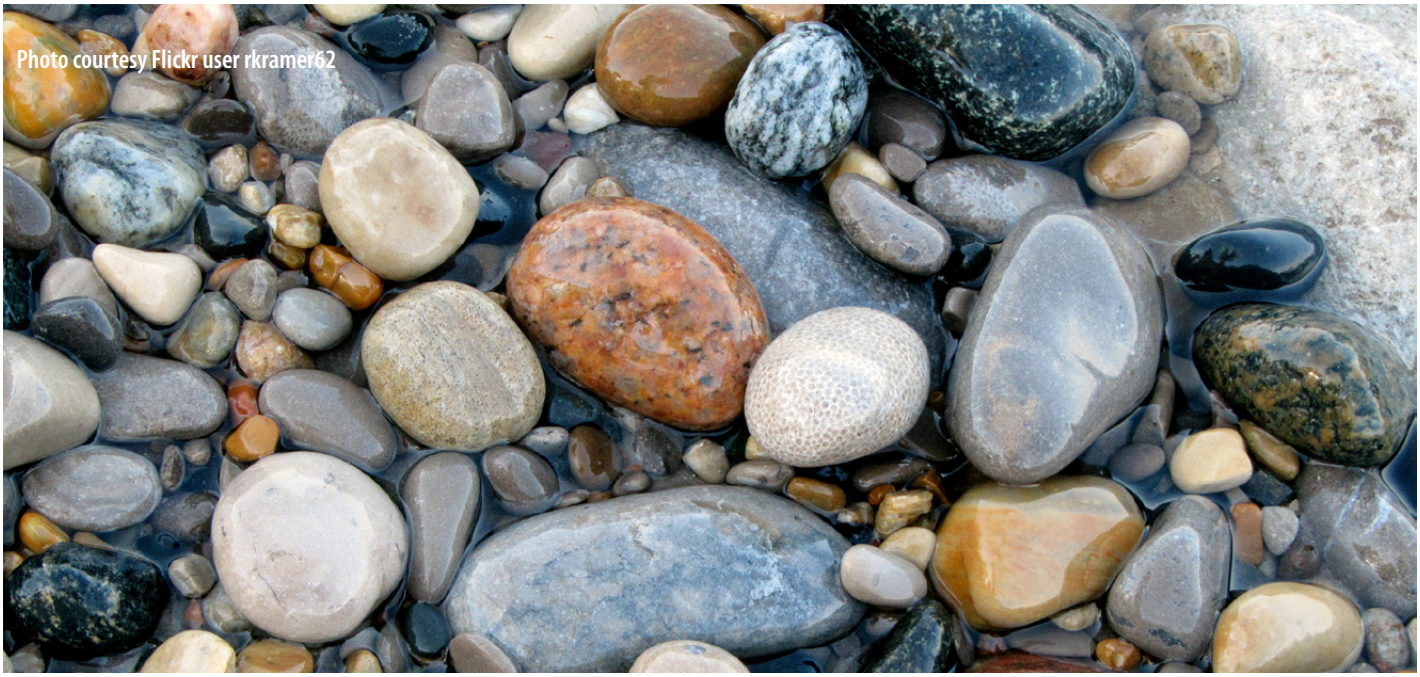
Study Introduction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1.1 Introduction

Educators are always looking at how to improve learning, given the resources they are provided and their skills as pedagogues. As a team of educators participating in a doctoral program in educational leadership, we have dedicated a year towards researching and reporting on a need articulated from colleagues working in a neighboring school district on the cusp of starting a ubiquitous computing project. Virginia Commonwealth University's (VCU) School of Education is a member of the Carnegie Project on the Education Doctorate (CPED) and presents its Ed.D. students the opportunity to study compelling problems of practice in the field of education through collaborative capstone projects, of which this dissertation is a result. It is our hope that this research will help our client school district to prepare and plan appropriately for their one-to-one computing initiative. It is also our hope that this document will help others following a similar path.

This document is organized in six chapters that follow. The **literature review** examines ubiquitous computing from its genesis with laptops to current trends with tablet-based computers and mobile phones. Our focus in the literature review includes elements of training for teachers and administrators, changes in school policy, and most importantly to us, the rationale for going "one-to-one."

The **methods section** covers the process we undertook with our research. Our study is a multi-case, qualitative case study design where we conducted focus group and individual interviews with personnel from five districts participating in one-to-one initiatives. We chose districts with varying student population sizes with a varying degree of experience using a variety of computing platforms. They also showed diversity in their economic climates and racial profiles.

The **case district profiles** present each district's indepen-

dent story in going "one-to-one." Each of the five sections in this chapter captures some of the successes unique to each district, in addition to the challenges they have faced.

The **analysis and logic model** chapter examines the similarities and differences among each case district, using a logic model we created based upon a process we observed followed by district personnel to start their ubiquitous computing programs. This cross-case analysis includes our interpretation of each case's story in light of going "one-to-one."

The **discussion and recommendations** chapter includes a discussion of our interpretation in addition to our recommendations for districts exploring ubiquitous computing, including recommendations for further research.

1.2 Research Team

Our research team collectively has over 65 years in the field of public education. As students at VCU, our educational leadership program has focused on developing us individually as leaders, with a cohort that has included students in higher education. At the same time, the capstone approach has developed our abilities with collaboration and team building.

Derrick Deloatch. Derrick is currently a middle school principal at a suburban school district in the metropolitan area of Richmond, Virginia. He holds bachelor of science and master's of teacher degrees from Virginia Commonwealth University. After spending ten years as a middle school science teacher, Derrick went back to Virginia Commonwealth University to earn a post master's certificate in educational leadership. Derrick has spent the last eight years in administration in both high school and middle school settings. Having worked in a district that has already implemented a one-to-one program, Derrick's participation in this research project has helped him gain insight into what other districts experienced while implementing their own initiatives.

John Hendron. John is currently an instructional technologist for a rural school district near Richmond, Virginia. He holds a bachelor of arts in music degree from the University of Rochester, a master of arts degree in music education from Case Western Reserve University, and a master of arts degree in instructional technology from Virginia Polytechnic Institute and State University. John's interest and expertise in the field of educational technology has been strengthened through this research process. John has served as a director for two terms for the Virginia Society for Technology in Education (VSTE). John's writing has appeared in ISTE's *Learning and Leading with Technology*.

Angie Kim. Angie has served as an associate principal in a suburban school district in the metropolitan region of Richmond, Virginia. She holds undergraduate degrees in history and psychology and a master of teaching from Virginia Commonwealth University. Angie worked as a classroom teacher while earning her endorsement in gifted education from the University of Virginia and a post master's certificate in educational leadership from VCU. She has also held a position as an onsite university supervisor for student teachers through VCU before becoming an administrator. Angie's love of bringing the real world to students through technology has helped her in this research. She hopes other districts will be able to use the information in this research project to help make decisions that best serve the needs of the students.

Shawnya Tolliver. Shawnya is currently an elementary principal in a suburban school district in the metropolitan region of Richmond, Virginia. She holds a bachelor of arts degree in elementary education from Wake Forest University. Shawnya obtained her master's degree in supervision and administration from Virginia Commonwealth University. She has been a classroom teacher, resource teacher, and assistant principal prior to moving into the principalship. Participating in this research study has been extremely beneficial to Shawnya as she

leads her school in the direction of instructional innovation. Information gleaned from this study will be a valuable resource as Shawnya continues to guide her staff towards deeper technology integration.

1.3 Capstone Committee

Our advisor is Dr. Charol Shakeshaft, professor of educational leadership at VCU. We have welcomed Dr. Shakeshaft's support to mold our research for our own needs and for the needs of our client. Our dissertation committee also includes Dr. Jonathan Becker and Dr. James Lane. Dr. Becker is currently the director of online learning for VCU, and an associate professor in the educational leadership department at VCU's School of Education. Dr. Becker's passion for technology in education has led to his own research in this field. Dr. Lane is currently superintendent of Goochland County Public Schools. His past experience has included adjunct teaching at VCU's School of Education, and providing leadership to districts involved in one-to-one computing projects.

1.4 Internal Review Board

Our team applied for, and received internal review board approval (#HM20000320) on January 16, 2014 to conduct the research involved in our capstone project. This was a required prerequisite to conduct research in one of our case districts. The research we conducted through focus group interviews and one-on-one interviews with key personnel from case districts posed no harm to participants.

1.5 Confidentiality of Case Studies

Each district we studied agreed to, and signed a memorandum of understanding that outlined the scope of our research. Because some of the districts did not want to be identified, we have not included the identity of any of the five case districts in this report. Some information was purposely not quoted verbatim to help maintain the confidentiality of participating districts. Documents referenced in the data analysis and discussion chapters are also not included in the appendices to maintain the confidentiality of districts.

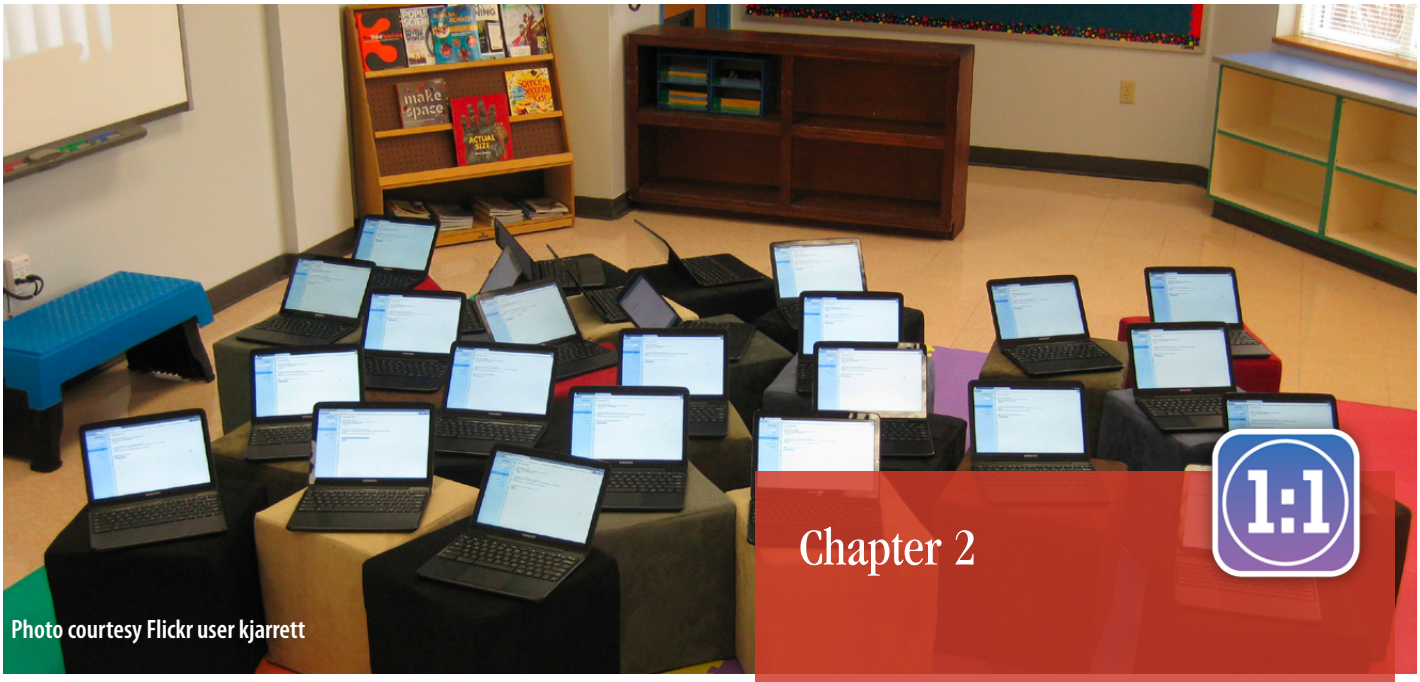
1.6 Statement of Appreciation

We would each like to thank our advisor and capstone chair Dr. Charol Shakeshaft, as well as our capstone committee members Dr. Becker and Dr. Lane for their help with designing our study. We would also like to thank our client team for the opportunity to explore the best practices involved in ubiquitous computing. Most importantly, we would like to extend thanks to our families and colleagues for their understanding during the intense period of our lives used to conduct our research and deliverables.

1.7 Format

This report was originally written in APA format. We adhered to the 6th edition of the *The Publication Manual of the American Psychological Association*. It is presented here in a modified, more accessible format, while maintaining APA reference style.

Literature Review



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Chapter 2

2.1 Introduction

2.1.1 Where Did One-to-One Programs Start?

One-to-one ubiquitous computing initiatives have been around since the late twentieth century. One-to-one computing is defined as an environment where students and teachers have access to wireless computing devices in the school and home settings (Negroponte, 2006; Penuel, 2006). The key features of these one-to-one programs are students and teachers having a wireless device, Internet capability, tools, and resources needed to complete their school related tasks (Abell, 2008). Several one-to-one programs have been implemented in states and districts across the United States over the last twenty-three years. In 2002, Maine was one of the first states to provide mobile devices to all middle school students and teachers with the Maine Learning Technology Initiative (MLTI). In 2002, The Freedom to Learn (FTL) program was Michigan's attempt to implement

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a similar one-to-one laptop program with its students and teachers. Texas also experimented with a one-to-one computing program from 2004-2008 with the Texas Technology Immersion Project (TIP). In 2006, Pennsylvania continued the trend with their own one-to-one laptop program by providing laptops to more than 356,000 students (Abell, 2008).

Individual school districts and schools have also initiated ubiquitous computing programs. Henrico County Public Schools, a district in central Virginia, distributed laptops to its secondary students and teachers beginning in 2001. Talbot County Public School System was the first school district to launch a one-to-one laptop initiative in the state of Maryland. Districts and schools across the country continue to join the ranks of schools and states implementing one-to-one initiatives. Nagel (2010) concludes that up to 37% of schools across the United States have explored one-to-one initiatives.

2.1.2 Successful Implementations

Districts on the path of implementing a one-to-one program can look to districts that have had the program in place over several years for strategies of a successful implementation. Analyzing the implementation process and identifying key program features of other districts can help determine the best course to follow for the greatest results.

Project RED, a research organization sponsored by major players in the educational computing industry, has established a rationale for what makes one-to-one programs successful. Districts such as Sunnyside Unified (Arizona), Irving Independent (Texas), Walled Lake Consolidated (Michigan), Mooresville Graded (North Carolina), and the Atlanta Public School (Georgia) are cited as success stories because they have reduced educational spending using technology, increased test scores in areas of need such as mathematics, increased student engagement and attendance, and reduced behavior problems in their schools (Project RED, 2013).

Mooresville Graded School District in Mooresville, North Carolina, was featured in a recent *New York Times* article, with an interview with their iconoclastic superintendent (Schwarz, 2012). Superintendent Edwards said, "It's not about the box. It's about changing the culture of instruction - preparing students for their future, not our past... You have to trust kids more than you've ever trusted them, your teachers have to be willing to give up control" (Schwarz, 2012). Edwards' district is now a tour destination for many district administrators planning for successful initiatives (Edwards, 2014; One to One Institute, 2013).

The Urban School, located in San Francisco, is another example of a success story. Educators put an emphasis on student created work in their project-based curriculum. The goal of the one-to-one was for students to show their learning through the creation of information and content instead of just consuming information. This transformation occurred through the school's focus on "seamless integration" (Lenovo & Intel, n.d.).

Jamestown Elementary School in Arlington, Virginia provided "tool kits" for every grade level. The tool kits support an array of wireless devices including tablets, notebooks and digital audio players. The kits are used to focus on content delivery skills, creativity, and collaboration. Conducting research, practicing math facts, taking notes, and creating presentations are some ways of using the devices in the classroom. The program was rolled out in increments by content since 2004 (Lenovo & Intel, n.d.).

There were various reasons and goals behind these computing initiatives. Whether it is to close the achievement gap, bridge the digital divide, or to create equity among students, all the schools, states and districts desire successful programs. The research surrounding these ubiquitous computing initia-

tives—using everything from laptops to more portable mobile devices—reveals insight into the theoretical foundations behind the desire to provide each and every student their own computer as part of their toolkit for learning.

2.1.3 Theoretical Foundations

The writings and theories of John Dewey (1997) have inspired generations of educators since the mid-twentieth century with approaches of instruction that advocate real-world experience. These concepts resonated with students of Piaget who championed *constructivism* and Papert, who championed *constructionism* (Ackerman, n.d., Fleischer, 2012, Harel & Papert, 1991). It was Papert (1993) who advocated for the power of microcomputer technology to make experiential approaches to learning inexpensive and efficient. Despite their attractive ideas about the acquisition and retention of information through experience, both Piaget's and Papert's ideas about education only slowly gained traction in American schools (Schön, 1992).

Papert and his colleagues at the Massachusetts Institute of Technology have been tireless in their advocacy for the use of computers as powerful learning tools (Turkle & Papert, 1990). Negroponte and Papert helped establish the One Laptop per Child Project, with the aim at providing low-cost computers to children in all parts of the world (Negroponte, 2006; OLP, n.d.). Key to Papert's theories is the idea that children should be in control of their learning (Harel & Papert, 1991). He wrote in *Mindstorms*, "We are at a point in the history of education when radical change is possible, and the possibility for that change is directly tied to the impact of the computer" (Papert, 1993, p. 36).

The advancement and sophistication of technology, in terms of both computing power and size, has made the prospect of putting a device in the hands of every learner palatable. Known by different names, ubiquitous technology programs or one-to-one initiatives are often tied to aims for enhanced instruction that adopt the student-centered and project-based modalities supported through constructivist and constructionist theories on learning.

2.1.4 Organization of the Literature Review

The central question facing a school district considering scaling-up learning opportunities with technology may be "why implement a one-to-one program?" The benefits and drawbacks are likely to be considered, including the effect on student achievement, cost, student engagement, attendance, and long-term benefits with unmeasured aspects of student achievement in schools, such as the development of twenty-first century skills (Kereluik, Mishra, Fahnoe, & Terry, 2013). In our first section, we examine the "why" question, providing a rationale for adopting a ubiquitous computing initiative.

Adding laptops or mobile devices such as e-readers, tablet computers, or cell phones to the school day provides enough change to the school environment to warrant training for teachers and administrators. Professional development efforts are routinely discussed in the research on one-to-one initiatives. However, training will not only focus on the operation of new digital devices, but will extend to modifications of teaching practices, adopting methods that resonate with today's students. Professional development is a key component towards the success of a ubiquitous technology program.

In addition, schools and districts implementing one-to-one programs must be prepared with policies and procedures that will facilitate success. Central to this effort will be the development of policies that set the groundwork for Internet safety, management of discipline, and protecting all stakeholders. Likewise, schools must adequately prepare for the additional work in acquiring and managing the new hardware and software used in ubiquitous programs.

One-to-one programs began to emerge twenty-three years ago. Since that time, research has focused on student outcomes and the requisite changes in pedagogy that have resulted in student achievement gains. Programs in current planning stages would do well to evaluate the successes and challenges of other programs already in production. We look at the research on established programs in our final section.

2.2 Reasons for Implementation

2.2.1 Technology is Ubiquitous

Schools across the United States are embracing ubiquitous computing. Districts are accomplishing this by expanding the number of computers available to students or "bring your own device" (BYOD) initiatives, where students bring their own computers, tablets, or cell phones to schools (New Media Consortium, 2013). One of the more studied methods is the one-to-one initiative, where schools provide a computing device to each student. In our age of digital access, ubiquitous computing allows educators to disband the notion of a computer lab. Through one-to-one initiatives, both students and teachers have a wireless enabled device that allows them the freedom of working anywhere, at any time (Abell Foundation, 2008; Jeng, Wu, Huang, Tan, & Yang, 2010).

2.2.1.1 Students and technology

Students today access the Internet as a part of their daily routine. According to the Pew Internet and American Life Project (2013), 95% of teens access the Internet, with 100% penetration at the 16 to 17 year-old age group (Nagel, 2013). However, the way the Internet is accessed has changed. Instead of sitting at a desktop computer at home, teens are using smartphones, tablets, and other devices for mobile access. Seventy-four percent of 12 to 17 year olds reported they use mobile devices at least occasionally to go online (Pew Internet and American Life Project, 2013).

2.2.1.2 Students and gaming

One reason for teens to go online is for social gaming. Today, video games include opportunities for social interactions over the Internet. A Kaiser Family Foundation report (2010) documented survey results among American students aged 8 to 18 and found that all age groups played at average, over an hour of video games daily. This was compared to over four hours watching television (Kaiser Family Foundation Study, 2010). Gaming opportunities range from mobile, handheld devices that include Nintendo DS, smart phones, and tablets, to console games (Xbox, PlayStation) and games played on a personal computer (Bissell, 2010). In each case, games can include online opponents and live interaction, no matter the format of the game (Bissell, 2010; Prensky, 2008).

2.2.1.3 Students and social media

More than playing videos games, teens spend a greater amount of time on social media sites. According to the Kaiser Family Foundation report (2010), 8 to 18 year olds spend 25% of their time with technology on social media versus 19% of their time on video games. Eighty percent of teens are accessing social network sites, such as Facebook, up from 55% in 2006 (Pew Internet and American Life Project, 2011).

A 2010 Pew study documented that 47% of American children receive their first cell phone between the ages of 10 to 11 (Lenhart, 2010). With more than one-third of teens in the United States owning smartphones and 23% owning tablets (Interactive Educational Systems Design, 2013), districts understand the importance and connectivity of technology to the students.

2.2.2 District Implementations

One-to-one computing initiatives can be a costly investment for districts. Henrico County Public Schools, located in Virginia, spent a reported $50 million dollars on their one-to-one

laptop initiative from 2001 to 2008. Maine's statewide program cost $41 million dollars in its beginning stages in 2002, an additional $41 million in 2006, and $49 million in 2007. (Abell Foundation, 2008). Even with the high costs, the reported successes and even failures of major school districts in Florida, Texas, South Dakota, and others, are motivating new districts to join the one-to-one movement. A survey conducted by the Interactive Educational Systems Design (2013) of 558 district technology leaders across the United States found 84% showed a high level of interest in implementing a one-to-one initiative within the next two years if budget allowed.

Districts are putting priority on integrating technology into the classrooms. In 2004, it was estimated that 4% of school districts across the nation participated in one-to-one computing (Bebell & Kay, 2010). Nagel (2010) estimated that 37% of school districts in the United States have implemented some form of one-to-one computing. Even if districts are not fully implementing one computer per child, the rate of technology available for students is rising. The national ratio of students to computers has decreased from 125:1 in 1983 to 4:1 in 2002 (Russell, Bebell, & Higgins, 2004). A recent survey of over 11,000 educators by Renaissance Learning reported that 18% of districts surveyed are currently piloting 1:1 initiatives (Renaissance Learning, 2014). In another survey, the National Center for Educational Statistics reported the ratio of students to computers with Internet access as 3.8:1 in 2005 to 3.1:1 in 2008 across the United States (NCES, 2011, Table 109).

2.2.3 Enhancing Instruction

One of the benefits districts cite for ubiquitous computing is that education is enhanced through technology (Brodzik, 2012; Bebell & Kay, 2010; Edwards, 2014; Harris, 2010; Storz & Hoffman, 2012; and Windschitl & Sahl, 2002). Many districts and schools articulate a desire for more personalized instruction for students (Short, 2011). In an appraisal of a one-to-one program looking at the impact on low socioeconomic students, Harris (2010) found teachers felt laptops helped individualize instruction with differentiated depth and pace for students. He also found students received personalized feedback for their learning. One-to-one initiatives also help classrooms to become more student-centered (Bransford, Brown, & Cocking, 2000; Dunleavy, Dexter, & Heinecke, 2007) as well as provide greater learning opportunities for challenging students (Mouza, 2008).

2.2.3.1 Access to knowledge

Technology has changed how we access knowledge. Students can search for information, share information, and come up with new information by synthesis (Hendron, 2010). Even textbooks are now online with additional videos and enrichment content accessible for students who want to dig deeper into a topic of interest (Dunleavy & Heilack, 2007).

In a study to evaluate effectiveness of iPods and iPads in a classroom, Crichton, Karen, and White (2012) found certain applications helped students create meaningful products to show understanding. The variety of accessible knowledge is why the teachers in a San Francisco High School reported that laptops provided students with a deeper understanding of content (Harris, 2010).

2.2.3.2 Twenty-first century skills

With additional sources of information comes the responsibility and wisdom of how to use that knowledge. Teachers are charged with showing students how to discern reputable information from the plethora of sites that come up from a simple *Google* search (Hendron, 2010). The skill to separate fact from fiction is a twenty-first century skill. Developing this information literacy skill is enhanced with access to technology. In addition, the gamut of twenty-first century skills involves a variety of additional skills that are either enhanced or changed with technology access, including problem solving,

communication, self management, and critical thinking (Edwards, 2014; Kereluik et al., 2013, Partnership for 21st Century Skills, n.d.; Rousseau, 2007). The meta-study of twenty-first century skill frameworks by Kereluik et al. (2013) found that three major sets of skills are articulated across fifteen widely available models: foundational knowledge (to know), humanistic knowledge (to value), and meta knowledge (to act). While knowledge about technology is only articulated in their model as one branch of foundational knowledge, the authors admit that both the presence and utility of technology fundamentally changes the development of humanistic and meta knowledge categories, such as life and job skills, culture competence, plus communication and collaboration.

Social learning management platforms allow students to talk to others in a way that takes learning to a higher level, facilitating the practice of twenty-first century skills. In *Edmodo*, a discussion thread could go on for days as students continue to search for information and add to the dialogue. Barrow County Public Schools, located in Georgia, has a dedicated *Edmodo* wiki page for its staff. On the site, teachers are encouraged to use *Edmodo* for developing a sense of community among students, safely teaching students how to behave in a social network with peers and adults, fostering twenty-first century skills like communication, collaboration, critical thinking, and creativity, as well as differentiating lessons by learning styles (Barrow County Public Schools, n.d.).

Google Applications allow for students to work simultaneously on one or more documents and spreadsheets with peers and teachers. On the *Google Docs* Tips and Tricks page, students are shown how to plan, work on, and chat about a project in real time even though classmates are in different locations (Google, n.d.). Another site, Khan Academy, allows students access to free instructional videos, supporting a flipped-classroom model. In a video testimony on the Khan website, teachers explain how students use the website to complete online exercises from which their progress is reported to their teacher immediately. Because access to Khan Academy is not limited to school hours, students can work beyond the school day, continuing discussions, extending the concept of "learning" beyond a typical class period (Khan Academy, n.d.).

2.2.3.3 Teacher role

Education leaders routinely target a desire to change classroom pedagogy with the implementation of one-to-one initiatives. Constructivist or constructionist learning styles are often cited as an end goal (Becker 2000, 2001; Brodzik, 2012; Keskin & Metcalf, 2011; Nicholas, 2006; Sandholtz, Ringstaff, & Dwyer, 1997; Short, 2011). Seymour Papert (1993) was instrumental in convincing the governor of Maine to embark on their ambitious online learning initiative (MLTI). Papert stated that all students needed to have a computer in order to fundamentally change our schools and that success would only be reached if the district offered one laptop for each child (Fleischer, 2011).

Educators are no longer the sole disseminator of information. Students are learning to locate and understand knowledge by collaborating with one another. This, in turn, has changed the teacher's role in the classroom. Instead of direct teaching, the teacher facilitates the students' learning, often through a project-based approach (Short, 2011; Sockman, 2007). Harvard professor Chris Dede describes teachers as shifting from an "explainer-in-chief to an orchestrator of learning" (Fairbanks, 2013, p. S7).

2.2.4 Student Engagement

Ubiquitous computing classrooms showed an increase in student engagement, motivation, participation, attendance, and ability to work independently (Apple Computer, 1995; Bebell, 2005; Edwards, 2014; Rockman, 1998; Rutledge, Duran, & Carroll-Miranda, 2007; Short, 2011; Silvernail & Lane, 2004). In a study of Maine's one-to-one initiative, survey results stated

30-40% of principals thought attendance and student behavior had improved and 70% reported there was a positive impact on student learning and motivation. The same survey indicated teachers felt motivation, engagement, and participation also rose for special education students (Silvernail & Lane, 2004). Lemke and Martin (2004) conducted a study in Indiana of their one-to-one initiative and found consistent teacher, parent, and student reports of increased student participation, more involvement in activities, increased time spent on schoolwork at home, and fewer behavior problems.

2.2.5 Student Achievement

In the era of No Child Left Behind, student test scores are a big factor in bringing additional resources into the classroom. Although some districts have cited laptops as bringing up test scores (Mann, 2008), there is little correlation between technology and standardized test scores (Rousseau, 2007). Surveys, interview perceptions, and non-standardized testing do report an increase in classroom achievement. The Abell Foundation (2008) reported test scores for students in Maine did not increase in any of the core content except for writing. Writing scores went up for two thirds of the students between 2000 and 2005. Increased use of the laptop in the writing process seems to have attributed to the scores. A New York high school decided to discontinue its one-to-one initiative after seven years due to a lack in student achievement, among other reasons including discipline problems related to misuse of the laptops and a continued lack of teacher understanding on how to use the technology in the classroom (Hu, 2007).

Rousseau (2007) suggests that we may never truly understand the impact of the laptop initiatives on standardized testing due to the tests assessing traditional learners, not those who have been taught in a method centered on technology users. At this point, classroom assessments may be a better gauge of student achievement in a ubiquitous classroom, such as performance-based assessments (Lewin & Shoemaker, 2011).

2.2.6 Equity Through Technology

Bridging the gap between achievement scores of high- and low-socioeconomic students is another reason cited for establishing a ubiquitous environment. Harris (2010) believes a laptop initiative provides great benefits to low-socioeconomic students, including expanding worldviews and improving career opportunities for students. The program can be a valuable educational investment for students and their families with financial needs.

Districts cite closing the "digital divide" as a goal within ubiquitous computing programs (Edwards, 2014; Zardoya & Fico, 2001). The U.S. Department of Commerce (2011) reported that people with less education, those with disabilities, lower income families, Blacks, Hispanics, and rural residents generally lag behind the national average for computer and Internet use. For example, in households making less than $25,000, 43% reported not having a computer. Four percent of higher income families reported not having a computer at home. Rousseau (2007) also agreed that family income drives whether a household has a computer or Internet for home use. A one-to-one initiative where students are allowed to take the device home can help narrow a portion of the gap. However, further research would need to be conducted regarding the impact of ubiquitous computing on underserved populations to truly understand the benefits (Harris, 2010).

Having students carry their laptops home also shows improvements in parental interest. Rutledge et al. (2007) found nearly every child had a parent with them at school meetings regarding implementation. Parents have also shown an increase interest in learning more about technology in the process. Lei and Zhao (2008) found parental involvement increased the year one-to-one laptops were implemented in a Midwestern middle school. Forty-six percent of parents reported they had

never worked with their child on homework in the beginning of the year. At the end of the year, only 32% of the parents reported the same. Also in the same study, 78% of parents said they never worked with their child on the computer. At the end of the academic year, only 54% made such reports.

2.2.7 Beyond the Classroom

Districts are putting laptops into students' hands as a means of preparing them for the workforce of tomorrow. "Fully 65 percent of today's grade-school kids may end up doing work that hasn't been invented yet" (Heffernan, 2011). The United States Department of Labor (2012) projects a 20.5 million job increase by 2020. People with master's degrees will have more opportunities to be employed than a person with only a high school diploma due to the increasing demand in specialized occupations. Educators understand how technology ties into future opportunities for students. Tasgold (2012) interviewed teachers who emphasized the significance of preparing our students for global competition through technology beyond high school.

Maine's vision in implementing the one-to-one initiative in 2002 was "to promote business development in Maine and statewide economic development by creating a workforce with a 21st century skill set" (Derringer, 2010). Preparing our students for the world beyond the classroom is an important factor in deploying mobile devices for every student for Maine, other states, and districts.

The one-to-one initiative has been implemented across the United States for various reasons, including increased student achievement, motivation, positive changes in instruction, closing the digital divide, and preparing our students for the future with twenty-first century skills they can apply to their work. All of these positive outcomes stem from the classroom and the daily interactions between teacher, student, and technology. In order to ensure the success of implementation, we need to make sure our teachers are trained and supported throughout the entire implementation and sustainment process.

2.3 Professional Development

2.3.1 Teachers are Change Agents

The literature is clear in reinforcing that teachers are the primary change agents in one-to-one computing initiatives, more than the new ubiquity of technology (Bebell & O'Dwyer, 2010; Dunleavy et al., 2007; Harris, 2010; New Media Consortium, 2013; Sprenger, 2010). Professional development is therefore omnipresent in discussions about the success of one-to-one initiatives (Donovan et al., 2007; Fogary & Fitzpatrick, 2013; Hernandez-Ramos, 2005; McKeeman, 2008; Peck & Sprenger, 2008, Penuel, 2006, Potter & Rockinson-Szapkiw, 2012; Schwab & Foa, 2001; Wang, 2000). The success of an initiative is directly correlated to the quality of professional development offered (Bebell & O'Dwyer, 2010; Lawless & Pellegrino, 2007; Potter & Rockinson-Szapkiw, 2012; Rousseau, 2007; Silvernail & Lane, 2004; Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011), maintaining that training is matched to a teacher's needs and ability levels (Burns & Polman, 2006; Walker, Johnson & Silvernail, n.d.). Professional development activities can be conceptualized around a school-based context, a societal context (involving parents), and around a disciplinary context (Klieger, Ben-Hur, & Bar-Yossef, 2010).

Before professional development begins, schools must first establish a vision for the initiative (Adelman et al., 2002; Sparks, 2002). For superintendent Mark Edwards, who has launched two one-to-one initiatives, the vision is part of a "moral imperative:"

The moral obligation to bridge the digital divide is the driving force behind our digital conversion initiative. We believe that, provided with the right tools and support, all

students can be successful academically, regardless of socio-economic status, first language spoken, or special needs (Edwards, 2014, p. 17; Apple, 2007, p. 55).

Wirt (2012) found in his assessment of successful schools that vision-forming was best achieved in groups that included teachers. The initiative's vision will drive the success of the implementation, based upon buy-in and acceptance by teachers, and to an extent, the community. Schools commonly articulate a vision based upon a desire for increased student achievement, improved instruction, student engagement, the support of the development of so-called twenty-first century and workplace readiness skills (Harris, 2010; Lei & Zhao, 2008; Nagel, 2010; Silvernail, Wintel, Walker & Bartlett, 2011). Successful one-to-one initiatives take place in schools and districts where teachers' philosophy of education and attitudes about technology synergize with a school's vision for the program (Becker, 2001; Burns & Polman, 2006; Cuban, 2001; Garthwait & Weller, 2005; Hall & Elliott, 2003; Inan & Lowther, 2010, Murphy, King, & Brown, 2007; Penuel, 2006, Venkatesh & Abrami, 2006; Wozney, Zhao, & Frank, 2003). Specifically, different methods of pedagogy are implemented in schools identified with success. When teachers do not share a belief about the impact that these types of pedagogy can have on student success, a barrier is created in leading teachers to change (Lawless & Pellegrino, 2007).

The literature identifies a number of different pedagogies associated with one-to-one implementations. These include:

Constructivist (or constructionist) approaches (Becker 2000, 2001; Brodzik, 2012; Keskin & Metcalf, 2011; Nicholas, 2006; Sandholtz et al., 1997; Short, 2011),

Student-centered classrooms (Bransford et al., 2000; Dunleavy et al., 2007),

Assessment-centered (Bransford et al., 2000; Dunleavy et al., 2007),

Project- or problem-based learning (Short, 2011; Sockman, 2007), and

Personalized learning (Short, 2011).

In almost every one of these approaches, the role of the teacher can be viewed along a continuum between a transmitter of knowledge to a facilitator or coach (Levin & Rivka, 2006-2007; Swan, van't Hooft, & Kratcoski, 2005). There is a strong held belief that teachers make a journey along this continuum towards the facilitator role through both classroom experience and professional development (Fairbanks, 2013; Lowther, Ross, & Morrison, 2003; Sandholtz et al., 1997).

The teacher's professional development along a continuum of pedagogy that includes the continued integration of technology with instruction and in student activities can be an emotional and distressing journey (Owen & Demb, 2004; Wirt, 2012). "Teachers may require some convincing that the change is not only in the students' best interests, it is in their best interests as well, especially if they will have to learn a significant amount of new processes" suggests Brodzik (2012), who evaluated a one-to-one laptop program for the Pittsgrove Township School District (Delaware). A teacher's worries and fears about beginning a one-to-one initiative often centers on how the change will affect them on a personal level (Brozdik, 2012; Donovan, Hartley, & Strudler 2007; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Gulek & Demirtas, 2005; Goldring & Greenfield, 2002). The result may be a reluctance to use new tools or new pedagogies (Moore-Hayes, 2011). Professional development strategies should acknowledge the stress associated with changed professional practice, through the choice of activities that minimize stress or through culture change in the school (Zhao & Bryant, 2006). Donovan et al. (2007) recommend that teachers "feel important and involved" in the professional development process (p. 279).

Several models have been developed to conceptualize a teacher's pedagogy along a continuum. A teacher's development in this area has been observed in connection with one-to-one initiatives (Rockman 1998, Russell et al., 2004). These may be useful reference points when designing a professional development program that differentiates training based on a teacher's needs and level of development.

2.3.1.1 ACOT Stages of Concern

The Apple Classrooms of Tomorrow (ACOT) project documented the impact of technology integration in schools over a ten-year period ending in 1995 (Apple Computer, 1995). One outcome of this project was the formulation of five "Stages of Concern" (Sandholtz et al., 1997). Conceptually, teachers migrate along these stages as their teaching develops over time with the adaptation or integration of technology. The stages include: entry, adoption, adaptation, appropriation, and invention. In the last stage, teachers have fully adopted computer technology and it has become a mainstay in their teaching (Sandholtz et al., 1997).

2.3.1.2 LoTi Framework

Inspired by the ACOT study, Dr. Christopher Moersch developed the LoTi framework (levels of teaching innovation) as a "conceptual model to measure classroom teachers [sic] implementation of the tenets of digital-age literacy as manifested in the National Educational Technology Standards for Teachers" (LoTi Connection, 2011). The framework identifies eight stops along a continuum, from non-use, awareness, exploration, and infusion on one end of the scale, to expansion and refinement on the other. Where the *ACOT Stages of Concern* are focused on the attitude of the teacher, LoTi is focused on what is taking place in the classroom, both in regards to how technology is being used, and the pedagogical choices made by the teacher. At the highest level of the scale (refinement), classroom learning is authentic, learner-centered, and is focused on problem-solving with the latest digital tools and resources (LoTi Connection, 2011).

2.3.1.3 SAMR

Puentedura's SAMR model is focused on identifying the role technology has in a learning activity (Puentedura, 2013). Substitution, Augmentation, Modification, and Redefinition frame four distinct levels of technology integration. In the first stage, technology replaces a previously used tool. In the second, the tool adds something new to the learning activity, but the new tool is used in a similar way to the old tool. In modification and redefinition stages, the new tool re-defines the learning task, or even allows for the creation of new tasks. This model's orientation on how technology is used may be useful for teachers to reflect on their current practices with technology (Harris, 2010).

2.3.1.4 Concerns-Based Adoption Model (CBAM)

CBAM describes the process of change people experience with the introduction of an innovation. This model is used in professional development as a situational framework, looking at both *stages of concern* and *levels of use* of the innovation (Loucks-Horsley, 1996). Seven levels of change include awareness, informational, personal, management, consequence, collaboration, and refocusing. The levels of use come with behavioral indicators; the scale is similar to the LoTi levels: non-use, orientation, preparation, mechanical, routine, refinement, integration, and renewal. Movement in the CBAM framework can be facilitated by time and mentorship (Hall & Hord, 2006).

2.3.1.5 Everett Rogers' Adopter Categorization and Diffusion of Innovations Model

Rogers' theory developed in the 1960s on the adoption of ideas and innovative technologies resulted in a framework to understand how new ideas take hold, his variables represented

by the innovative practice, communication channels, time, and the environment or "social system" (Rogers, 2003). He identifies these social groups as the innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003). This theory has been tested in a variety of contexts, including in educational settings to understand how teachers integrate new technologies into instruction (Philipp, Flores, Sowder, & Schappelle 1994).

Classroom teachers can be effective agents in changing the teaching and learning with new tools and new pedagogies. The new tools include laptops, mobile devices, and software that can replace paper and pencil, but go beyond and offer new ways of discovery and communication (Hendron, 2008). Professional development efforts start with the identification of what changes and tools will be implemented. A teacher's beliefs about the need and impact for change, and the tools that will help bring about change, must be considered as part of the professional development process. Several continua have been shared that illustrate the process of change. Identifying where teachers are along any one of these models with relation to their teaching style may aid the trainer in grouping teachers in like groups to maximize training time and talent.

2.3.2 Professional Development is a Requirement

Knowing how to operate a computer or mobile computing device is not enough to ensure the success of teachers in a one-to-one environment (Dawson, Cavanaugh, & Ritzhaupt, 2008; Ertmer, Ottenbreit-Leftwich, & York, 2006; Rousseau, 2007; Schwab & Foa, 2001; Wild, 1996). Edwards writes, calling ubiquitous computing a "digital conversion": "Success in a digital conversion classroom depends more than ever before on the talent, initiative, and skills of the teacher" (Edwards, 2014, p. 97). The TPACK model conceptualizes a teacher's knowledge into three categories: knowledge of content, knowledge of pedagogy, and knowledge of technology (Li & Ni, 2010; Mishra & Koehler, 2006). The TPACK model posits that in order for the integration of technology to be effective, a teacher will utilize a synthesis of knowledge specific to the content being taught, the tools available, and the instructional needs of students (Harris et al., 2010). The best models for professional development, therefore, offer opportunities for using technology *in situ*, based around specific content or content disciplines (McKeeman, 2008), with approaches that position the teacher in a role as facilitator (Conley, 1993; Gross, Truesdale & Bielec, 2001; Lawless & Pellegrino, 2007). Those who have observed or studied successful one-to-one implementations advocate for professional development that ultimately comes to focus on student-centered classroom pedagogy with new tools (Dawson et al., 2008; Lowther et al., 2003; Holcomb, 2009). Professional development must also change constantly to meet the changing needs of teachers (Donovan et al., 2007; Culp, Hawkins, & Honey, 1999).

2.3.3 What Gets Covered?

2.3.3.1 Pre-deployment workshops

Most professional development programs described in the literature start with a pre-deployment workshop with teachers—which may last from a number of hours up to ten days (Lowther, Ross, & Morrison, 2001; Rousseau, 2007). Many descriptions and studies of one-to-one initiatives recommend providing teachers with the tools and training before students anywhere from six months to two years in advance (Burns & Polman, 2003; Holcomb, 2009; McKeeman, 2008; Windschitl & Sahl, 2002). These sessions are focused on productivity with technology: turning it on and off, launching programs, Internet searching, and learning applications with application as general creation tools (office software such as email, word processing, spreadsheet, presentations) or applications with more specific curricular focus (research databases, math software, spelling drills) (Nicholas, 2006). Both researchers and practitioners both recommend starting with the basics of new tech-

nology in an effort to allow teachers to feel comfortable with new tools (Bebell & Kay, 2010). Recommendations for when to implement this training vary, from six months up to two years prior to deployment of the tools with students (21 Steps to 21st Century Learning, 2009). The amount of time spent with this type of training may differ based upon a teacher's comfort level with productivity using the school's chosen tool. Several implementations used or recommend at least nine hours covering these basics (Penuel, 2006, p. 333).

2.3.3.2 Training for teaching with technology

Once teachers feel comfortable with using new technology, professional development efforts change to address classroom pedagogy (Dalgarno, 2009; Donovan et al., 2007; Murphy et al., 2007; Potter & Rockinson-Szapkiw, 2012). It is not uncommon for teachers to report that an initial training is inadequate alone (Storz & Hoffman, 2012). This training will vary depending upon the age level of students and the content areas or disciplines for which a teacher is responsible. The literature cites many examples with poor outcomes where professional development did not focus upon classroom pedagogy with a curricular context (Lowther, Strahl, Inan, & Bates, 2007; Ertmer et al., 2012). A focus on pedagogy is apropos since the major aim in many one-to-one deployments is a change in the methods used to run a classroom, towards a model where the teacher can be described as a coach, guide, or facilitator, including what are called "neomillenial" learning styles (Dede, 2005). Ertmer (2005) calls for training to include "why technology is the best tool to address the content knowledge" (p. 12; Mishra & Koehler, 2006).

2.3.3.3 Third tier training

Some of the literature describes a continuation for professional development with pedagogy, but other examples of training exist. In their case study of a middle school laptop program in the American Midwest, Storz and Hoffman (2012) described the third year of teacher training to focus on blended learning, centered around what students can do with laptops when they go home (Fairbanks, 2013). Potter and Rockinson-Szapkiw (2012) advocate for a tier of training after basic operations and applications as: "technology integration with mentor and community support" (p. 23). In Gorder's study of a one-to-one program (2007), the third phase of instruction after "technology integration" was focused on "engagement activities" for students (p. 20). Dede (2011), however, has called for an end to the concept of *technology integration*, and instead recommends a focus for training around teaching, learning, assessment, and productivity using technology.

2.3.3.4 Training for efficiency

Some schools include training on managing discipline issues associated with a one-to-one deployment before, during, or after training on teaching methods. Others include so-called "advanced training" on more advanced applications and even computer repair (Bebell & Kay, 2010). Since technology advancements happen quickly, schools rarely run out of material to introduce as part of a continuous professional development program (Dalgarno, 2009). Studies have supported sustained training programs, in part, because teacher progress towards changes in pedagogical styles take a significant investment in time (Bonifaz & Zucker, 2004; Lawless & Pellegrino, 2007; Sandholtz et al., 1997; Sheingold & Hadley, 1990).

The literature is weak in its description of training on discipline issues despite the fact that it is often cited as a symptom of one-to-one programs. Typically, schools with low incidents of student discipline do not experience significant discipline issues with technology. Likewise, schools with high socioeconomic populations enjoy better records with student discipline involving one-to-one deployments (Rousseau, 2007). Nevertheless, the literature supports an assumption that professional development time should be allocated for teacher method-

ologies to minimize instructional inefficiencies in one-to-one environments (Brodzik, 2012; Livingston, 2006; Zucker & McGhee, 2005).

Professional development time aimed at reducing discipline issues can be spent on "objectionable materials, online predators, copyright violations and plagiarism, viruses and hacking, netiquette behavior, and privacy issues" (Lemke & Martin, 2004, quoted in Brozdik, 2012). Some of this energy can be used on constructivist-style teaching methodologies (Gulek & Demirtas, 2005). There is a correlation of low incidents of student discipline issues with technology when students learn in classrooms that embrace constructivist-style pedagogy (Devaney, 2010). In her study on student distraction, Tasgold (2012) found that by providing strict assignment deadlines and teaching students self-regulation strategies, student discipline issues could be reduced.

2.3.3.5 Training should be continuous

Successful one-to-one deployments offer, or their stakeholders recommend, continuous professional development (Blumenfeld et al., 1991, Burns, 2002, Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Wang, 2000). While a professional development effort may start with formal training in a workshop-style setting to cover productivity with the tools, a continuous program will provide a variety of new learning opportunities that support an assortment of adult-friendly learning modalities, including collaboration (Potter & Rockinson-Szapkiw, 2012; Russell et al., 2004). Time for professional development is an omnipresent requirement to ensure success (Bebell & O'Dwyer, 2010; Milken Exchange on Education Technology, 1999; Abell Foundation, 2008; Nachmias, Mioduser, Cohen, Tubin, & Forkosh, 2004). Silvernail and Lane (2004) correlated the amount of time teachers used laptops in the Maine laptop initiative with their time of participation in professional development activities. A continuous program must adapt itself to accommodate the needs of teachers at their appropriate ability levels (Donovan et al., 2007; Rockman, 2000; Sandholtz et al., 1997; Windschitl & Sahl, 2002). Quality continuous programs also consistently address the needs of teachers, by providing training on what they need to know (Donovan et al., 2007; Hall & Hord, 2001). This may be facilitated by using teacher surveys (Rousseau, 2007), or by including teachers on professional development planning committees or teams (Wirt, 2012). Teacher needs can also be met through a number of strategies that help promote an efficient, adaptive continuous professional development program. McKenzie (1999), Peck and Sprenger (2008) and Short (2011) collectively advocate for teachers to have individualized professional development plans, which could embrace a number of the following strategies.

2.3.3.6 Professional development strategies

The first strategy described in the literature is offering planning time or "common staff time" for training (Brodzik, 2012, Fogarty & Fitzpatrick, 2013; Wirt, 2012). This strategy for finding time for professional development is attractive for a number of reasons. It can be offered when teachers are already available with colleagues in the same subject areas or grade levels, fostering collaboration (Overbaugh & Lu, 2008, Stager, 1995). This allows for training to focus on pedagogy within a subject area or discipline (Holcomb, 2009, Rousseau, 2007) and supports an embedded development environment preferred by teachers (McKeeman, 2008).

The second strategy is the formation and use of professional learning communities (PLC) within a school (Burns, 2002; Hall & Hord, 2006; Fogarty & Fitzpatrick, 2013; McKenzie, 1999; Spires, Wiebe, Young, Hollebrands, & Lee, 2012). The PLC, when properly utilized, promotes collaboration among teachers (Livingston, 2006). Teachers can use time within their PLC to share best practices, practices to avoid, and bring colleagues up to speed on the technical aspects of using technol-

ogy (Burns & Polman, 2003). PLCs can also provide teachers the opportunity for reflection (Brodzik, 2012).

The next strategy is providing on-site opportunities (Walker et al., n.d., Gorder, 2007). Tubin & Chen (2002) concluded that implementation of new skills introduced during professional development is aided by offering training in a teacher's school. Whether or not the training can always be offered through PLC meetings or via common planning time, teachers prefer to have professional development activities in their own school buildings (Dalgarno, 2009). Kopcha (2012) reports in his study of technology integration with elementary teachers that the "interviews suggest that the situated professional development activities helped create an environment that supported teachers' decisions to integrate technology" (p. 1109). Teacher participation levels in professional development have been higher as revealed in studies on one-to-one implementations when offered in the teachers' schools (Rousseau, 2007). Wirt (2012) studied successful principals in one-to-one environments, where this strategy was offered as "embedded professional development," during the workday. A collaborative model of training, offered during the day, was more attractive to teachers (McKeeman, 2008) in lieu of top-down, presentation-led workshops (Dalgarno & Colgan, 2007).

Professional development is better when it is grounded in the subject area or discipline. One-to-one programs do not change curriculum content to "fit" the technology; good programs "bend" the technology to fit the content (Tasgold, 2012). This strategy honors the acknowledgement in the TPACK model of the definition of three separate and unique knowledge bases: knowledge of content, knowledge of pedagogy, and knowledge of technology (Spires et al., 2012). A subject or even an individual lesson may dictate different ways of using the same devices or application software to fit the content.

Another professional development strategy that is often recommended in one-to-one deployments, or in technology integration programs, is the use of a technology mentor to provide personalized, just-in-time training and coaching for teachers (Silvernail & Lane, 2004; Penuel, 2006; Zhao, Pugh, Sheldon & Byers, 2002). In Virginia, the Department of Education has defined this role as an *instructional technology resource teacher* (Virginia Department of Education, 2008). Potter and Rockinson-Szapkiw (2012) advocate for school administrators to assign technology mentors to teachers based on their demographic characteristics (p. 24). Mentors can model pedagogy using technology with students in the classroom (Dalgarno, 2009; Peck & Sprenger, 2008; Sockman, 2007; Zhao & Bryant, 2006) in addition to providing one-on-one training (Lewis, 2012). The witnessing of how technology can improve instruction is identified by Ertmer and Ottenbreit-Leftwich (2010) as a significant agent for a teacher's adoption of new pedagogy. This collaboration between mentor and teacher encourages involvement from the teacher to provide expertise related to content while learning about technology.

Some practitioners recommend the use of outside trainers or enrolling in university courses (Danielson, 2009; Fogarty & Fitzpatrick, 2013; Lei & Zhao, 2008, Sockman, 2007). Specialists affiliated with the brand or platform of technology that is adopted can help with technical concerns or provide training support for deployments. Many large-scale deployments used this model due to the consistency of training among schools in a district or across an entire state.

Another example cited in the literature is the use of student experts to provide training and technical support (Silvernail & Lane, 2004; Lee & Spires, 2009). In addition to having instructional support, having technical assistance is seen as a critical component towards success in the one-to-one initiatives studied by Penuel (2006). In some scenarios, students are on call for providing support in exchange for class credit. In others, students are identified with their level of comfort so they

can answer questions for teachers with just-in-time support. Those who employ the model of student experts cite the dual benefit to the arrangement, by providing students experience with leadership within the school while also giving technical support to teachers (Martinez, 2009).

Professional development can also be provided in a self-serve model for teachers. Schools and districts can create websites to house digital tutorials, instructional videos or podcasts, model lessons, or subscribe to sources of digital training materials (Burns & Polman, 2003; Massachusetts State Legislature, 2004; Muir, 2003; Wirt, 2012). Likewise, some schools use virtual courseware to offer anytime learning opportunities with more structure (Fogarty & Fitzpatrick, 2013).

The final strategy for supporting a one-to-one program is providing teachers time to re-write the curriculum (Dalgarno & Colgan, 2007; Tee & Lee, 2011; Teacher Professional Development Through a Collaborative Curriculum Project, 2010; Wirt, 2012). While not all teachers who successfully migrate to a student-centered, facilitated model of teaching need their curriculum documents re-written, re-writing helps some teachers re-conceptualize their role in the classroom with technology present and others to follow a plan that's been written to reflect the ubiquity of technology and the school's adoption of refined pedagogical models (Penuel, 2006; Swan et al., 2005; Warschauer, 2007). Re-writes should focus on using technology to support knowledge-building and discourse, and inquiry-based behaviors for students (Mouza, 2008). Rousseau (2007) reports in her study of one-to-one laptop programs that teachers interviewed appreciated the collaboration with technology support personnel when working on curriculum development (p. 137).

2.3.4 Professional Development Should Include Administrators

Successful technology integration takes place in schools where instructional leaders, such as principals, are providing a clear vision with clear expectations (Adelman et al., 2002; Edwards, 2014; Rousseau, 2007; Sparks, 2002). Wirt (2012) calls for successful administrators to adopt an "entirely different set of skills" to lead with one-to-one initiatives (p. 5). Leaders communicate why the technology has been provided, in addition to the instructional goals and areas of focus for a school (Becker, 2001; Cuban, 2001, 1986; Zhao & Frank, 2003). One-to-one programs fail when there is a lack of instructional leadership related to the presence of new technology (Cooley & Reitz, 1997; Ertmer & Ottenbreit-Leftwich, 2010). To be successful, leaders should be flexible with expectations for teachers as a school begins its journey with ubiquitous computing (Burns & Polman, 2003).

Research supports the assertion that good principals are both change agents and models, respectively for teaching and teachers (Brockmeier, Pate, & Leech, 2010; Wirt, 2012). Modeling takes place when principals attend and engage in the same professional development as teachers, despite the fact that principals have a different set of professional development needs in their role. School administrators also model when they use technology to communicate with stakeholders, establish a social media presence, and promote instructional uses of technology during teacher meetings (Fogarty & Fitzpatrick, 2013; Wirt, 2012).

School administrators can also provide or lead professional development efforts, either by themselves or with the help of a school's technology mentor or other district support staff. In some schools, school-based administrators may need to plan for professional development, keeping in mind issues of who participates, how to provide time, and how to cover the associated costs (Donovan et al., 2007; Livingston, 2006). Administrators can plan for professional development by asking teachers about both their frustrations and successes (Rousseau,

2007). The use of communications media such as newsletters or podcasts from administrators can be used to help teachers by promoting the administrator's vision and ideas about best practices (Fogarty & Fitzpatrick, 2013). Administrators can also engage in their own professional development through the same means, by subscribing to quality resources, attending conferences, and by following blogs and podcasts (Fogarty & Fitzpatrick, 2013).

2.3.5 Including All Stakeholders

While our discussion so far has focused on two groups of stakeholders who work in a school, the wider collection of stakeholders may be considered for a comprehensive professional development program. This societal view includes parents and their children.

The literature includes examples where "training" was offered to students as a separate instructional opportunity outside of normal classroom instruction (Martinez, 2009; Murphy et al., 2007). Similar to the initial training many schools or districts provide at the start of a one-to-one program, schools can make time to train students on hardware maintenance, school rules and expectations, and basic operations such as connecting to network services, turning-in assignments, or using email. Training students on technology basics is done to provide a consistent knowledge transfer to all students, and to maintain classroom time for covering curricular content (Murphy et al., 2007). Niles (2006) found that communication tools such as email and instant messaging "created opportunities for teachers and students to interact outside the traditional communications patterns" (p. 69). In her study of a one-to-one environment, Niles found that through student-teacher communications, both stakeholder groups "changed their patterns of communication with individuals outside of the school setting" (p. 79).

Student training may also be offered to build a school's capacity for student experts. Silvernail & Lane (2004) describe a successful implementation of student experts in Maine with the formation of *iTeams*, that offer just-in-time technical assistance in schools.

Less detail is discussed in the literature about training provided for parents. It is clear that schools should not shy away from communicating the goals of the program beyond the technology (Rutledge, et al., 2007). In Wirt's study of principals in highly successful implementations of one-to-one programs (2012), he found those leaders all communicated with parents about the program's goals. Parent training may include some of the same information provided to teachers and students, such as basic operation of the computing device. School rules and regulations connected with use of the device, especially following the school's acceptable use policy, is routinely covered (Niles, 2006; Rutledge, et al., 2007). Niles (2006) advocates for a "deeper understanding of the distractions of technology and the uses of the Internet" (p. 127). This is ripe fodder for professional development with parents and with students, which often is associated with social networking (Dalgarno, 2009; Harris, 2010). In their study of a one-to-one program, Bebell and Kay (2010) found that it was commonplace to find teachers helping students using this technology with homework. Just as with the continuous recommendation for professional development with teachers, all stakeholders, including administrators, students, and parents should be engaged in ongoing communication (Brodzik, 2012) and training opportunities related to the program's progress and goals.

2.4 Policy and Procedures

The rapid upsurge in implementation of one-to-one initiatives in school districts across the United States not only provides examples of how to integrate technology through classroom instruction, but also provides examples for creating and utilizing

policies that guide teachers, students, and families in accessing resources available through computing devices. Flowers and Rakes (2000) recognized, in their analysis of acceptable use policies in K-12 schools across the United States, surfacing issues and concerns surrounding access and use by students and teachers must be acknowledged. Through trial and error, schools and districts have used their own experiences and the experiences of others to guide the development of policies and structures that support the implementation and maintenance of one-to-one computing initiatives. The digital world and the enthusiasm for technology from the current generation of students are forcing schools to adapt in ways never before imagined (Gorder, 2007).

2.4.1 Establishing a Culture of Support

The presence of technology in an educational setting is an innovation that has been consistent over the last two decades. In spite of the consistent presence of technology in classrooms, the use of computing devices continues to garner the attention of educators, administrators, school boards, researchers, parents and students, due to the changing applications dictated by ever-changing priorities over school improvement.

The idea of expanding the use of technology in the classroom is exciting for some teachers and students; meanwhile for others it produces apprehensions. Rutledge (2007) concludes that it is important the apprehensions be acknowledged and addressed so teachers can maintain a positive focus on the academic benefits of the valuable learning resource provided by technology. Ensuring teachers and students are proficient in using computing devices is only part of the process for reducing negative perceptions. Knowing the expectations of use associated with the technology is another factor in reducing anxiety. Owen and Demb (2004) illustrate the six leadership strategies in support of technology implementation as understanding fundamentals, forging strategies, identifying champions, supporting innovation, communicating vision and goals, and celebrating success. These strategies can provide the foundations leaders can utilize to foster a school culture that supports the use of technology.

2.4.1.1 Leadership expectations for the use of technology

Educational leaders set the pace and vision for how technology will be used in classrooms. Providing teachers, students, and parents with clear expectations for use of devices communicates the leadership's vision and goals. "Districts should develop a set of expectations for use of technology in the classroom by which teachers know what is expected of them" (Wirt, 2012, p. 81). In addition, school leaders can further enhance the integration of technology by aligning the school goals and technology goals. An environment that fosters experimentation from teachers and students is likely to sustain the innovation (Hargreaves, 2006; Sockman, 2007).

In schools where communication regarding the use of technology is unclear or in contradiction with the school's culture, teachers can discount the value of the tool and may actually discourage students from utilizing technology. Walker et al. (n.d.) indicate in their study of high schools that technology use varied from school to school. Some schools in the study could be described as having a seamless integration of technology whereas in other schools, some teachers instruct students not to bring their computers to class. In schools where the instructional technology department partners with the teachers, staff, and administrators, there appears to be much more use of technology in the classroom. In those schools, technology is becoming embedded into the school culture; as a result, students are motivated to bring their computers everyday (Walker et al., n.d.). Districts should have a team that includes all stakeholders that continually revisit and refocus the vision for the use of technology in a one-to-one environment (Wirt, 2012).

2.4.1.2 Develop and revisit the technology plan

The development of a comprehensive plan that communicates the goals and objectives of a program provides a road map for the implementers. Implementing a one-to-one computing program requires a structured level of planning that encompasses more than timelines and lists of resources. "Teachers wonder how they will adapt to the presence of new tools and what kind of support they will receive to learn to use them. Principals contemplate the administration of such programs and must consider changes in teaching assignments, in-service schedules, and the school's technology infrastructure" (Windschitl & Sahl, 2002, pp. 170-171). Due to the continual innovation associated with technology, a technology plan should be an evolving document that is updated consistently. Dalgarno (2009) recommends clearly communicating and revising shared, benchmark-driven policies on an ongoing basis to assist in unifying an understanding of the program.

The ubiquity of technology in school districts across the United States and a focus on twenty-first century skills likely led to the development of a U.S. Department of Education document *Enhancing Education Through Technology Act of 2001* (2013). This act provides assistance to the states so that they may implement and support a comprehensive system that enhances student achievement utilizing technology in elementary and secondary schools. In addition, the act aides states and localities in the "acquisition, development, interconnection, implementation, improvement, and maintenance of an effective educational technology infrastructure in a manner that expands access to technology for students (particularly for disadvantaged students) and teachers" (U.S. Department of Education, 2013, para. 3). The Federal document additionally notes the following purposes and goals that influence state technology plans:

To promote initiatives that provide school teachers, principals, and administrators with the capacity to integrate technology effectively into curricula and instruction that are aligned with challenging state academic content and student academic achievement standards, through such means as high-quality professional development programs.

To support local efforts using technology to promote parent and family involvement in education and communication among students, parents, teachers, principals, and administrators (para. 3).

Though funding sources are not always guaranteed, the ideals behind the act provide states with a foundation for developing technology plans. States face challenges due to the impact of funding on policies (Nagel, 2012). Plans and policies must comply with a multiplicity of rules, and regulations at the local, state, and federal levels.

With the advent of the *Enhancing Education Through Technology Act of 2001*, states began developing technology plans that filtered down to individual divisions and directly impacted instruction. The state technology plans address goals and objectives that each district is expected to address and implement through district specific technology plans. As stated in the Virginia Department of Education's technology plan's executive summary, "division technology plans need to follow the procedures outlined in the state plan, should reflect state and local goals, and be useful to all stakeholders" (Virginia Department of Education, 2010 p. 13). Goals and objectives listed within the plan impact policy by delineating expectations for the type of learning environment that is provided by teachers for their students, addressing Internet safety, setting the expectations for access to personal computing devices, and for using data to adjust technical support (VADOE, 2010).

2.4.1.3 Maximize technology integration

School- or district-level policies should support teachers in their

efforts towards technology integration above management issues such as discipline and technical concerns. "It is critical that the leadership implement policies and routines that allow teachers to focus on the significant task of integration, rather than distracting management issues such as charging laptop batteries or preventing students from accessing inappropriate Internet sites" (Dunleavy et al., 2007, p. 451). According to a study conducted by The Abell Foundation (2008) that researched Maine's one-to-one computing initiative (MLTI), professional development was identified early in the process to be integral to program success. Each school selected a teacher to be the Regional Integration Mentor of the area. The mentor was charged with helping to design practices and procedures for laptop use within the designated "exploration schools," as well as assisting MLTI staff in the development of a statewide network of professional development related to technology integration in middle schools (Abell Foundation, 2008). The Laptops for Learning Task Force (2004) claims that the biggest obstacle standing in the way of the one-to-one laptop computer program is the lack of guided support teachers receive in an attempt to integrate technology into the classroom. When learning to use digital tools, teachers should focus on fully and smoothly integrating them into each lesson, with the goal of ensuring that technology is used to support the curriculum, rather than to define it (Kingsley, 2007, p. 55).

2.4.1.4 Required levels of training and support

As researchers review the growing number of one-to-one programs, a common theme continues to arise. This recurring theme is the need for on-going training and support for teachers (Penuel, 2006; Fleischer, 2011). Because teachers possess a variety of skill levels, a need for structured levels of training and support is required. Policies that denote required levels of training have been drafted in various school divisions (Murphy et al., 2007; Rousseau, 2007).

Rousseau (2007) addressed the impact of requiring teacher training as part of state and district-wide policies in the review of the California Technology Assistance Program (CTAP). "C-TAP is a statewide program that provides educational technology support to K-12 schools" (p. 133). The intent of the program is to strengthen the knowledge and use of technology by program participants. In a 2005 to 2006 evaluation summary of the CTAP program, 90% of survey respondents indicated they had an increased readiness to use technology in their classrooms after receiving CTAP services (California Department of Education, 2013).

Rousseau (2007) examined the new K-8 school in a Southern California suburb. Lincoln School was built with a focus on science and technology as part of the school's design. As part of the one-to-one implementation program, the school's policy required that all current district teachers complete the two levels of training from CTAP. This expectation of training was explained to candidates during the interview phase. The principal communicated to the teachers "that the laptops would be used regularly during instruction and for projects" (p. 133). Rousseau questioned the teachers and they confirmed they knew the expectations before being hired.

University researchers Murphy et al. (2007) participated in the implementation and study of a laptop initiative for high school students. They describe the training policy as follows:

Teacher and student training and curricula integration support was structured in two tiers. The first level of support consisted of monthly in-service days for the 24 participating teachers from the three schools. The in-service day activities included hands-on training with hardware and software, curriculum integration discussion groups, and on-going training through the ACTNow! software purchased by the school district. In addition, pairs of graduate assistants were assigned to visit each of the schools once per week for

the full school day. Graduate assistants met with teacher clusters during both team and individual planning periods, provided in-class hands-on lessons with students to support teacher curricular goals, and served as a resource for curriculum development as well as technology integration into classrooms (p. 58).

These studies illustrate systematic policies for providing professional development related to ubiquitous technology implementations. The technology plan for the State of Virginia includes an objective that addresses providing "high-quality professional development to help educators create, maintain and work in a variety of learner-centered environments" (VADOE, 2008, p. 13). Providing meaningful staff development that address teacher concerns may reduce anxieties that are commonly associated with technology implementation such as lack of knowledge regarding how to use a computing device and ways to utilize the device in the classroom to support instruction (Storz & Hoffman, 2012).

2.4.1.5 Stakeholder buy-in

Wirt (2012) found in his study of principals involved in successful one-to-one programs that a key piece in the development of an effective technology program is communication with all stakeholders. The majority of leaders in one-to-one schools indicate they were significantly or fully engaged in the communication of the vision and technology planning process. The responsibility of being the sole communicator or carrier of the vision should not fall completely on the leader. The leader must find ways for the staff to realize the vision for a one-to-one environment so that they can see their role in the change and have an early personal connection to the process.

A strong factor that has an impact on the use of computers in schools is the amount of community support for the program. Murphy et al. (2007) document that some communities seem to value the one-to-one program and view it as a privilege for their children while other communities are leery of the technology and resistant to allowing their children access to a device. In schools where there was community support, the program management was much easier. Murphy et al. recommends scheduling convenient, optional technology training courses for parents. Parental understanding of a one-to-one program may translate into more general support by parents and the community for additional technology in the schools.

2.4.2 State, District, and Acceptable Use Policies

2.4.2.1 State policies

As schools work to ensure that technology is embraced as part of everyday instructional practices, states and districts are giving attention to the policy implications associated with ubiquitous technology.

The Virginia General Assembly proactively has promoted the Internet's instructional benefits while protecting students from its risks. In 2000, a state law required school divisions to develop acceptable use policies [AUP], which provide Internet guidelines for students and teachers. The following year, state and federal laws authorized the installation of filtering software to prevent students from accessing potentially harmful materials (VADOE, 2007, p. 2).

In addition, the Virginia Legislature's House Bill 58 mandates that school districts develop AUPs that "include a component on Internet safety for students that is integrated in a division's instructional program" (VADOE, 2007, p. 2).

2.4.2.2 District policies

The development of a district policy provides an overall framework for addressing wide-ranging issues that may arise from the use of technology in the classroom. McKenzie (1995) explicitly addresses the role of district policies in guiding technology practices.

A comprehensive district policy provides guidance and direction regarding access to potentially controversial information and then connects the information to pre-existing policies. This, in turn, unifies policies with curriculum and the selection of curriculum materials, thus making clear the expectations for staff supervising student use of technology. Technology policies need to align with other policies that are currently in place to support learning (McKenzie, 1995). Harris (2010) notes that one-to-one laptop programs share general common characteristics; however, the specifics of individual programs may vary from district to district and from school to school. He cites policies regarding laptop ownership, technological configurations of computing devices, and whether students lease or buy their computers as examples of requisite policies. Furthermore, clear, comprehensive policies from the district level reduce the risk of staff, students and parents from getting caught up in protest of moral dilemmas. McKenzie (1995) continues by advising the inclusion of comprehensive policies that would outline specific staff rights and responsibilities. He also identifies the areas that most district policies address: contact with objectionable materials, questionable materials, questionable persons; objectionable behavior and material, destructive behavior; violation of privacy rights and of access rights. "Typically, in most districts there will be a set of procedures, which spell out in considerable detail how to translate into school realities that broad principles stated in the board policy. For Internet, these would speak to program development, rules and sanctions" (p. 5).

2.4.2.3 Acceptable use policies

An AUP is a written and sometimes signed contract between an Internet user and an Internet provider, whether the provider is a university, a school, or a commercial vendor. The AUP states that the user will use the Internet only for certain delineated purposes. In schools these purposes are usually defined as educational and curricular (Truett, Scherlen, Tashner, & Lowe, 1997, p. 52). Flowers and Rake (2000) recognize that "Internet connections in K-12 schools offer students and teachers an almost overwhelming array of information and communication possibilities. Those connections also bring a wide array of problems and concerns that must be addressed to ensure safe and appropriate use of the Internet" (p. 353). They also found four areas of concern addressed in AUPs. These areas dealt with liability, online behavior, system integrity issues, and quality of content. Truett et al. (1997) contend that AUPs should be part of a school district's set of policies and be school board sanctioned and approved.

School board and district policies provide the general guidelines for the use of technology in schools. Walker et al. (n.d.) recognized there are also "administrative requirements when implementing one-to-one technology," with decisions about formulating and revising an acceptable use policy (p. 3) Flowers and Rakes (2000) conducted a descriptive and qualitative analysis of surveys and content of school policies across the United States that indicated K-12 schools are using AUPs to address the issues and concerns surrounding the Internet. Most policies are developed at the district or school level and must be compliant with the Children's Internet Protection Act (CIPA) (FCC, 2013). Areas of liability, online behavior, system integrity, and content quality are key issues contained in AUPs. Violations of these policies can result in the loss of Internet access or other consequences (Rutledge et al., 2007).

The underlying premise behind AUPs is to keep students safe while utilizing the plethora of resources that are available through the use of technology. Williard (2007) outlines several issues that school boards must consider when developing AUPs, including educational use, supervising and monitoring, meaningful consequences, accidental access to pornography, inappropriate blocking, Internet safety, and responsible use. Truett et al. (1997) found the average length of sample AUPs was slightly less than four pages. The discrete content compo-

nents identified in the AUPs were: mission or goal statements, disclaimer statements, parental consent forms, netiquette, consequences for inappropriate behavior statements, network security statements, and orientation requirement statements.

According to the Virginia Department of Education's AUP guidliens, the AUPs for school divisions in the state of Virginia are required to address "(1) access to and transmission of data and information with the K-12 environment and (2) any technology-based device in the school or personal device brought into the school." In addition, there are fourteen components that are required, including a "statement on the educational uses and advantages of the Internet in a school or division" and a "disclaimer absolving the school division, under specific circumstances, from responsibility" (VADOE, 2013, para. 6). This web page also lists resources that divisions can use to develop their own AUPs.

2.4.3 Preparing for Acquisition

During the acquisition phase, areas for consideration are methods for deploying devices, providing technical support, addressing practical and logistical issues, as well as including leadership strategies to support implementation (Brodzik, 2012). Walker et al. (n.d.) recognize that the physical and administrative process of deploying a one-to-one program requires a significant amount of staff resources, especially from administration and technology staff, regardless of the type of computing device.

2.4.3.1 Planning for deployment

Professional development needs for implementation of one-to-one programs must address strategies for deploying devices to staff members. Brodzik (2012) recommends in his study that districts need to provide staff members with the devices at least six months prior to full implementation and deployment to students. This process allows time for staff members to become comfortable with the device, request any needed support, and utilize the devices as a tool for planning and delivering content to students (Sandholtz et al., 1997; Sheingold & Hadley, 1990). Having policies in place that ensure professional development prior to implementation may help better prepare teachers for ubiquitous computing. Teachers that have a stronger foundation and knowledge of technology prior to using it in the classroom are able to focus less on basic skills. Instead, these teachers are able to concentrate more on curricular development and integration according to Rousseau (2007).

2.4.3.2 Technical support

Though technology is a tool for opening up the world to students, teachers, and parents, there are technical issues such as crashing hard drives, viruses in the computer system, printers not setting up correctly, and complicated software programs that may not be user-friendly. These issues could hinder a teacher, student, or parent from embracing the computing device as the tool it is intended to be. Thus, easily available access to technical support is a component that may increase the continuity of acquisition and ease concerns for the user. Prior to implementation of ubiquitous computing, district and school plans should include procedures for technical support. The Fredericksburg City Public Schools Technology Plan states a commitment to "properly maintain network equipment, software, and peripheral equipment" (Fredericksburg City Schools, 2010, p. 14). Similarly, Fairfax County Public Schools (FCPS) has a comprehensive technology plan that includes attention to technical support through the Office of Information Technology Operations (ITO) and the Office of Information Technology Support Services (ITSS). "Fairfax County Public Schools has built a standard, consistent approach in providing technology support and services to ensure that technology is adding value to the overall goals of FCPS" (Fairfax County Public Schools, 2013, p. 54). Both of these Virginia schools districts model their technology plans after the goals that are

provided in the Virginia Technology Plan (VADOE, 2010).

2.4.3.3 Practical and logistical issues

Classroom arrangements may need to change at the start of an ubiquitous computing initiative. There are both pedagogical and logistical reasons for these changes. Consideration has to be made regarding using hardware and software comfortably in the classroom to ensure there is access to needed structures. Location of outlets for charging computers and creating areas for hands-on and collaborative group activities may require the teacher to make adjustments to classroom furniture. Safe locations must be established to ensure the devices are stored and maintained properly to prevent damage to the machines (Brodzik, 2012). A list of practical and logistical issues are explained by Dunleavy et al. (2007):

1. Fragile or excessively heavy machines;

2. Limited desk space;

3. Inadequate battery life;

4. Software deficiencies;

5. Data loss;

6. Scheduling problems;

7. Online research offered instructional challenges for them because of concerns that students might access inappropriate materials (i.e. games, pornography, etc.), or waste time with inefficient or ineffective searches;

8. Unreliable Internet access;

9. The use of video in the classroom can lead to a high level of noise and some students intentionally use this as a distraction (authors note that although headphones for each student can help mitigate this distracting effect, this creates yet another management problem);

10. Infrastructure inadequacies;

11. Networked laptops detracted from effective teaching and learning, further exacerbated by the one-to-one student to networked laptop ratio (p. 442).

Considering and planning for the areas mentioned above during the preparation for acquisition stage of deployment supports a proactive approach for implementing one-to-one computing. Districts committed to making these initial investments can ensure the success of the ubiquitous computing program (Zardoya and Fico, 2001).

2.5 During Implementation of One-to-One Mobile Computing

After the mobile devices are placed in the hands of the teachers and students, the focus shifts toward positive and negative outcomes and the supports needed to sustain the implementation. Several researchers found changes in teaching pedagogy (Bebell & Kay, 2010; Harris, 2010; Storz & Hoffman, 2012; and Windschitl & Sahl, 2002), changes in student engagement (Bebell, 2005; Lewis, 2012), increases in negative student behaviors (Harris, 2010; Lewis, 2012; McKeeman, 2008; Nicholas, 2006; Rousseau, 2007; Tagsold, 2012; Walker et al., n.d), and the need for multiple levels of technical support (Grimes & Warschauer, 2008; Sockman, 2007) during one-to-one technology initiatives. As school districts plan their one-to-one initiatives, it may be useful to examine some of the outcomes that have occurred during implementations by other school districts around the country.

2.5.1 Changes in Pedagogy

Teachers must make several modifications to their existing instructional practices when mobile devices are introduced into their classrooms. Winschitl and Sahl (2002) found that teachers make these pedagogical changes through the utilization of the new technology. With the expectations from the administration that the devices be incorporated with increased

frequency, teachers are moving toward a constructivist learning style (Winschitl & Sahl, 2002). According to Short (2011), "constructivist learning occurs in the one-to-one computing environment when students are engaged in their own learning using technological resources available such as the laptop for virtual learning, field trip simulations, media creation and conceptual visualizations, and web-based discussion boards as instructional strategies" (p. 9).

Other researchers have also found similar shifts towards a more constructivist pedagogy during one-to-one implementations. Storz and Hoffman (2012) conducted pre-and post-implementation interviews with 47 students and eight teachers in a Midwestern urban middle school. The researchers wanted to know whether students' and teachers' experiences had changed since receiving the mobile devices. Storz and Hoffman found that there was a pedagogical shift towards more project-based learning by the students. "We also found patterns indicating changes in teachers' teaching styles. Students and teachers reported less whole-class, lecture-format instruction and more small-group and individualized instruction" (Storz & Hoffman, 2012, p. 10). Even with mobile devices being available to each student, the pedagogical shift of instruction depends on the teacher. Harris (2010) investigated the effects of one-to-one student laptop programs in five schools in the San Francisco Bay Area. He focused on changes in instruction and how these changes affected the implementation of the laptop in low socioeconomic settings. Data was collected from interviews, focus groups, and surveys with administrators, teachers, and students from five schools. Harris found that the participants gave examples of how the mobile computing initiative improved the learning environment and changed the way teachers taught. "Participants agreed that the laptops and the associated tools and resources provide teachers opportunities to create innovative instruction" (Harris, 2010, p. 109).

Bebell and Kay (2010) conducted surveys with 163 teachers implementing a one-to-one computing initiative called the Berkshire Wireless Initiative (BWLI) in Massachusetts during the third year of implementation. The program provided Apple laptops to students and teachers in five middle schools. One of the research questions was to see if the BWLI program created "fundamental changes in teaching strategies, curriculum delivery, and classroom management…" (p. 8). Bebell and Kay used an online survey and compared it to a previously administered survey. The researchers found that teachers did change their pedagogical approach to teaching with the laptops. Teachers were also reporting that they used the laptops to enhance their instruction by finding additional materials via the Internet.

The various studies summarized above collectively support the notion that the implementation of mobile one-to-one computing can fundamentally change teachers' instructional pedagogy. This infusion of technology creates an environment where teachers can utilize a constructivist learning style and where the overall learning becomes student-centered (Ertmer et al., 2012).

2.5.2 Changes in Student Motivation and Engagement

While one-to-one mobile computing implementations have brought about changes in teacher pedagogy, these initiatives have also affected student motivation and engagement (Bebell, 2005; Silvernail & Lane, 2004; Swan et al., 2005). Bebell (2005) surveyed over 400 seventh grade students and 35 teachers during the first six months of a one-to-one laptop program in six schools in New Hampshire. The survey questions focused on access and use of technology. He found that students almost doubled their use of the laptops during the implementation period across all major subject areas. The teachers reported improvement in student participation, motivation, attendance, and their ability to work independently and in groups. In ad-

dition, over 90% of teachers reported an increase in student engagement for both traditional and at-risk students. Students also displayed more effort in the quality of products they produced, were more willing to do additional drafts when assigned writing assignments, and they seemed to work harder on classwork (Bebell, 2005).

Silvernail and Lane (2004) found similar results for student engagement when they evaluated the initial phase of the Maine Learning Technology Initiative (MLTI). Using a mixed-method approach and analyzing over 26,000 student and 1,700 parent surveys, along with site visits, observations, and document analysis, the researchers found that almost 70% of the students reported being "more involved in school and with their classmates" and that the laptops made "school more interesting" (pp.17-18). The students reported spending more time on editing their work. As one student was quoted as saying:

It's helped my writing a lot. That's probably my biggest improvement. Because I wouldn't really want to read it over and over and over again…like check every word…And now I have spell check and I have a thesaurus right on there. I'm big into poetry and like writing poetry. It's a lot easier to do that…write little and use the thesaurus to find a better word" (Silvernail & Lane, 2004, pp. 17-18).

The teachers in the study reported an increased in engagement and organizational skills after the laptops were introduced into the classrooms. For example, during a teacher feedback interview, the following comment was made:

It gives those kids who weren't involved before; they are right in there. It's a teaching and learning thing. It gives me the chance to allow them to shine, which I couldn't have done before. It would have been really hard to find things that I could have involved them in to get them interested in school. Now, they are here everyday and they like being able to help (p. 22).

Maintaining the students' interests should be one of the primary goals of any one-to-one mobile device implementation. If students are not engaged with the new technology-based instruction, the device may not be used frequently. The results of the studies referenced above indicate that there is a link between student motivation and engagement after devices are placed in schools.

2.5.3 Issues Arising from Implementation

Implementing a one-to-one program can bring about several challenges for teachers and administrators within a school. The issues that arise from these challenges can cause teachers to become frustrated. These factors include time constraints, the amount of staff development, problems with student behavior, and the lack of technical support (Abell, 2008; Brodzik, 2012; Rousseau, 2007).

Classroom management is an essential component to being able to implement a successful one-to-one program (Brodzik, 2012). Teachers with strong classroom management skills will have a higher chance of being able to change their curriculum to coincide with the introduction of technology (Brodzik, 2012). Even with strong discipline procedures, laptops in every student's hands can be a forum for a variety of challenges. Rousseau (2007) compared discipline during one-to-one laptop programs in low- and high-socioeconomic (SES) schools in Maine. She collected qualitative data through observations and interviews and found significant discipline issues related to the laptops mainly in the low SES school. Students were intentionally damaging their laptops. Participants in the study reported abuses ranging from alcohol being poured on the laptop to students "trying to round the edges by dragging it on the street out a moving car" (Rousseau, 2007, p. 131). These distractions also occurred in the classroom setting. During un-

structured time, students were observed listening to music, accessing inappropriate websites, and instant messaging (Rousseau, 2007).

Tasgold (2012) found similar results from an analysis of experiences with one-to-one computing among teachers and students in a high school in North Carolina. She conducted interviews with 16 students and three teachers and observed six classrooms. She found students using proxies to bypass Internet filters meant to keep them from accessing inappropriate websites. Students in the study also admitted that having the laptop tempted them to do things, such as checking their emails or social networking sites (Tasgold, 2012).

These distractions from the use of laptops were evident in a similar study conducted by Niles (2006), who focused on the teacher and student perceptions of a one-to-one laptop implementation at a high school located in Wichita, Kansas. Niles collected data from focus groups composed of 13 school teachers and 18 students during the fourth year of the program. A major finding of the study was that teachers reported technology created more distractions, such as students sending instant messages via the laptop during lessons. Teachers felt that monitoring inappropriate use of the laptops took away from instructional time. "The real problem with computers is that many students abuse the "fun" features like iChat, iTunes, and downloading games. This is a problem that we as teachers can monitor. . .controlling it takes so much time out of instruction that it is almost not worth it" (Niles, 2006, p. 105).

The off-task behaviors documented in the studies mentioned have also been reported in other one-to-one implementations, including one of the largest, in the state of Maine. Walker et al. (n.d) analyzed data from over 60 staff and students interviewed from eight high schools participating in the Maine Learning Technology Initiative (MLTI). Even with extensive filtering systems to block inappropriate websites, the participants in the study reported off-task behavior by students. Staff members experienced difficulty monitoring these off-tasks behaviors by students and cited how drama created by students communicating on social networking sites at home was brought to the school setting (Walker et al., n.d.).

Successful implementations of one-to-one programs occur when districts develop strategies to prevent discipline issues associated with giving students computing devices (Lei & Zhao, 2008). Adequate monitoring systems, training for teachers, and implementing detailed acceptable use policies are best practices for success.

2.5.4 Types of Supports Needed

Teachers have a large task when it comes to developing curriculum for a one-to-one mobile classroom. They are transitioning from having access to two to three computers or moving the class to a computer lab at designated times to all students accessing a mobile device in a ubiquitous computing classroom (Soloway et al., 2001). Finding the time and knowing how to develop technology-based lessons can be very difficult. Both administrators and technical personnel must work to support teachers in maintaining the one-to-one implementation (Laptops for Learning Task Force, 2004; Dalgarno, 2009; Ertmer, et al., 2012; Grimes & Warschauer, 2008; Inan & Lowther, 2010; Penuel, 2006; Silvernail et al., 2003; Sockman, 2007).

Inan and Lowther (2010) surveyed teachers in 76 Michigan schools participating in the Freedom to Learn (FTL) grants. There were a total of 379 teachers who participated in the online survey. Inan and Lowther found that overall administrative support for technology is the greatest factor affecting a one-to-one laptop integration. Technical support was also among the top three supports needed after professional development (Inan & Lowther, 2010). In a study conducted by Ertmer et al. (2012), twelve classroom teachers were selected and interviewed on their pedagogical and technology practices during

instruction. Ertmer's findings were similar, with the teachers in his study listing barriers such as lack of administrative and technical support as affecting their implementation of technology into the classroom.

Teachers participating in the first phase of the MLTI also reported a lack of technical support. The mixed-methods evaltuion by Silvernail and Lane (2004) of the MLTI consisted of data collected through surveys, site visits, classroom observations, and document analysis. The researchers found close to 70% of the teachers surveyed wanted more technical support during implementation. There was also a 50% approval rate for student-based technology teams within the schools. These technology teams were comprised of students who helped other students and teachers with laptop issues. The Grimes and Warschauer (2008) study of a one-to-one laptop implementation in a school district in California showed similar results. Qualitative data using surveys, interviews, and observations showed that although teachers felt the program was a success, many still reported technical support issues related to the mobile devices (Grimes & Warschauer, 2008).

As school districts begin the discussion of whether to move towards a one-to-one mobile implementation, they may focus on the type of devices and infrastructure needed to institute the program. These are important factors to consider; however, it is also important for these districts to look further into supports needed to sustain the programs, such as administrative and technical (Laptops for Learning Task Force, 2004; Bonifaz & Zucker, 2004; Grimes & Warschauer, 2008; Penuel, 2006). Research findings indicate administrative support for the mobile initiatives as an important key for the success of the programs (Laptops for Learning Task Force, 2004; Dawson & Rake, 2003; Ertmer, 2012; Penuel, 2006). School districts that conduct careful analysis of these factors will be able to make better decisions on how to create the best strategies to ensure the success of their one-to-one initiatives.

2.6 Conclusion

2.6.1 Why Do Districts Do a One-to-One?

There has been a gradual shift to ubiquitous computing for the past twenty-three years. Districts have embraced a one-to-one initiative for various reasons, including increasing student engagement, student motivation, changing teacher pedagogy, bridging the digital divide, and preparing our students for the work force through twenty-first century skill development. Whether a district communicates one or multiple reasons for implementation, it is important that technology be considered as a tool, not the deliverer of instruction. As the literature demonstrates, instruction has focused on changing classroom pedagogy towards a constructivist model. For the teacher, the move along a continuum from a transmitter of knowledge to a facilitator of learning can be greatly enhanced with technology.

2.6.2 Professional Development

The vision for ubiquitous computing environments in schools involves changes in classroom pedagogy to reap the benefits of improved student outcomes (Law, Pelgrum & Plomp, 2008). The changes fall under different labels used by educators, including constructivist learning, project-based learning, and student-centered learning (Bransford et al., 2000; Nicholas, 2006; Short, 2011). These pedagogies work, it is believed, because they cater to so-called neomillennial learning styles (Dede, 2005). Schools utilize professional development to not only address the basic operations of computers, but also to adopt the innovation of new technology into classroom instruction (Dalgarno, 2009; Penuel, 2006). Having ample opportunities for professional development, addressing teacher needs, and including training for dealing with the realities of one-to-one environments such as discipline and classroom efficiency (Lawless & Pellegrino, 2007; Rockman, 2000; Windschitl & Sahl, 2002) are ingredients towards developing

a successful and sustained adoption of technology. Training, like most aspects of educational programs, should include all stakeholders, including students, administrators, parents, and teachers (Klieger, et al., 2010; Wirt, 2011).

2.6.3 Policies and Procedures to Support an Initiative

As districts and schools continue to move forward with implementation of ubiquitous technology, utilizing federal, state, and district technology plans facilitates in creating school cultures that support technology use in the classroom (U.S. Department of Education, 2013). On the school level, technology plans are collaboratively developed to support the vision and goals of the district and school leadership (Wirt, 2012). These plans address maximizing technology integration, providing levels of training and support, and fostering stakeholder buy-in (Dunleavy et al., 2007; Walker et al., n.d.). The plans also include the development of mandated acceptable use policies that reflect federal, state and district guidelines for promoting Internet safety for all users with clearly defined expectations and consequences for technology use that comply with the Children's Internet Protection Act (Flowers & Rakes, 2000; McKenzie, 1995; Truett et al., 1997; VADOE, 2007). Incorporating policies and procedures within a technology plan prepares a district for ubiquitous technology acquisition, including planning for deployment, securing technical support, and dealing with practical and logistical issues. Inclusion of the outlined policies and procedures provide a foundation for the implementation of a one-to-one computing initiative.

2.6.4 Expectations Confirmed in Research

The amount of research regarding one-to-one implementations has grown since the first program was introduced in the early 1990s (Johnstone, 2003). States and districts planning to implement their own one-to-one initiatives can use the information from various researches to create their own successful programs. Planners need to analyze the successes and challenges of one-to-one programs in other states and districts while they are formulating a clear purpose, providing staff development prior to and after the delivery of the devices, and establishing clear policies and procedures for their own districts (Cavanaugh, Dawson, & Ritzhaupt, 2011; Chandrasekhar, 2009). They will find that several of these initiatives have resulted in changes in teacher pedagogy, student engagement, student behaviors, and technical support structures (Bebell, 2005; Bebell & Kay, 2010; Grimes & Warschauer, 2008; Rousseau, 2007; Tasgold, 2012; Walker et al., n.d.; Windschitl & Sahl, 2002). Understanding how these factors may affect all stakeholders in the process will help the planners make better decisions as they finalize plans to move forward with their own one-to-one implementations.

Methodology


Photo courtesy Flickr user snre

Chapter 3

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3.1 Introduction

The purpose of our research was to discover how school districts successfully implement ubiquitous computing initiatives and present our findings to a client. Our client expressed a desire to understand the process of implementing a one-to-one computing project. The leaders in the client school division had previously led efforts towards enhancing instruction through blended learning models using available technology with an online learning management system called *Edmodo*. "Blended learning," as they defined it for us, referred to the use of *Edmodo* and other online resources to replace more traditional, direct instruction by teachers. Their new plans involve expanding the access students might have to technology and online learning resources beginning in the middle school grades using Chromebooks[1].

1 A Chromebook is a type of inexpensive laptop made by different manufacturers running the *Google* Chromium operating system.

We chose a narrative, multiple case approach that will exhibit the successes and challenges behind five districts that have already implemented one-to-one programs. The multiple case study approach described by Stake (2006) defines a major umbrella concept which dictates why a study takes place, called the *quintain*. A *quintain* "is an object or phenomenon or condition to be studied" (Stake, p. 6, 2006). The *quintain* for this study is the facilitation of ubiquitous computing in a school environment. In chapter four, we will profile each of the five locations separately as an individual case. In chapter five, we will compare our findings across the locations chosen for this study using a logic model we developed based on the experiences across our five cases. This dual presentation will preserve the uniqueness behind each site's work towards ubiquitous computing, including their successes and challenges. At the same time, the dual presentation will help us articulate best practices in light of the collective experiences across five cases. An analysis of themes was conducted and comparative information was gleaned from all interviews with each district's implementation teams. We will present our client school district an appraisal of best practices for beginning a ubiquitous technology program aided by this methodology.

The primary research questions for this study are:

1. What policies and procedures do districts have in place to support the success of their one-to-one computing initiative?

2. What professional development efforts were undertaken in districts with one-to-one initiatives to promote success with deployment and instructional goals?

3. What challenges do districts identify in their implementation of one-to-one initiatives?

Through the analysis of both our series of focus groups and interviews with district implementers, plus a collection of documents used to support the programs, we address these research questions through a desire to capture the experience behind each site's journey in planning, purchasing, and deploying an individual computing device for every learner (Stake, 2006).

3.2 Participant Characteristics

Stake advocates the selection of cases should be based on three main criteria:

"Is the case relevant to the quintain?",

"Do the cases provide diversity across contexts?", and

"Do the cases provide good opportunities to learn about complexity and contexts?" (Stake, 2006, p. 23).

The research team selected five school districts using these guidelines. The major criterion for selection of each district was that the district had to have a one-to-one computing program in which the students were allowed to take the technology home. The research team took into consideration our client's request for districts with similar characteristics to their own, however, the research team's goal was to select school districts that varied in population size, deployed different brands and form-factors of technology (tablets, laptops, netbooks), and differed in the longevity of deployment. Four districts were located on the east coast of, and one district was located in the midwest of the United States.

Table 3-1 compares the school districts' racial diversity, the devices chosen for their one-to-one programs, and their sizes. Although the ethnic background of students did not emerge as a theme with our analysis, we thought a comparison of socio-economic factors might help other district leaders reading this study compare their own district to the ones studied here.

The researchers interviewed administrators and technology coaches within each of the school districts. Personnel included superintendents, assistant superintendents, principals; direc-

Chromebooks use the *Google* Chrome browser as its only software, relying upon cloud-based applications.

Table 3-1: *District Demographics*

School District	Devices	% Free/ Reduced Lunch	% White	% Black	% Hispanic	% Asian/ Hawaiian	% Alaskan Native/ American Indian	% Other/ Multicultural	Total Student Population
District 1 Suburban	Mac OS/ Windows Laptops	37.13	44	36	7	8	0	3	48,000
District 2 Rural Fringe	iPads	64.75	62.4	21.6	10.6	.5	.3	0	7,027
District 3 Rural Fringe	iPads	36.09	62	29.4	2.9	1.1	.3	0	5,500
District 4 Rural Distant	iPad Minis	25.85	72	22	5	1.5	.5	.5	2,470
District 5 Suburban	Chromebooks	58.11	68	13	10	.8	0	8	10,533

Note. *Demographic information about each district was gleaned from their district websites and from federal and state departments of education websites.*

tors of instruction, technology, instructional technology, and professional development; and technology coaches (also referred to as instructional technology resource teachers, technology resource teachers, or eLearning coaches in some districts). The selection of the interview participants was based on two factors, whether the individual had a role in the planning or implementation of the one-to-one program, and whether the person's schedule allowed participation in an interview or focus group as a type of criterion sample (Mertens & Wilson, 2012, p. 424).

3.3 Evaluation Design

The districts were contacted beginning in July, 2013. Members of the research team emailed representatives of chosen districts to schedule interviews and to request documents related to their one-to-one implementation. In the initial email, we introduced ourselves and attached a document (see Appendix A) containing an overview of our purpose and goals for conducting the research. Four of the counties responded back with verbal/email consent. One district referred us to an internal application process that required approval from their Department of Research and Planning before proceeding. We received approval from the district on September 17, 2013 with the contingency that research could begin after we receive Institutional Review Board (IRB) approval (see Appendix B). We submitted the complete IRB application to the VCU IRB Board on November 4, 2013 and received approval on January 16, 2014.

In early November, 2013, one of the districts that had initially showed interest in participating in our study chose not to continue. We reached out to our capstone committee members, who recommended another district to contact. We confirmed participation in December, 2013 with the new district. Both districts had the common trait of their leaders deploying Chromebooks to their students.

Interview dates were set with each district based on the convenience and availability of personnel. Memoranda of Understanding (MOU) detailing the study's scope were sent to the districts before interviews took place (see Appendix C). We conducted focus groups and interviews between October, 2013 and February, 2014.

One district invited us for a site visit before setting up an interview date. Two members of our team participated in the site visit, in addition to site visits in two other districts with all four members of our team. During these site visits no data was collected, but visiting classrooms did help us conceptualize some of what was discussed by participants later, in our focus groups and interviews.

A week before each interview date, a member of the research team emailed the district contact or interview participants a reminder about the upcoming interview. The email included a copy of our research team members flyer with our pictures and contact information (see Appendix D), a copy of the interview questions (see Appendices E and F), a copy of an interview consent form (see Appendix G), and a copy of the list of documents we needed related to the implementation (see Appendix H). When applicable, the district contact was asked to forward the documents to all interview participants.

Two versions of the interview questions and procedures were created by the team. Version one was used with six interview participants from one district. The Capstone Committee members gave suggestions to modify some of the wording of the questions. Version two of the interview questions and procedure guide was used with all other districts. We later followed up with personnel from the first district with additional questions not originally included in the first version of questions.

3.3.1 Steps Taken to Enhance Credibility

A level of familiarity existed with each district, which facilitated

relationship building with participants. Individual members of the research team utilized professional relationships with site representatives to make contact and request participation from the selected districts. The credibility of the research team was established during multiple communications via email and phone conversations with the representatives of the districts. Additionally, the team members flyer listed the credentials of each researcher. The capstone team director, Dr. Charol Shakeshaft, is also a formal member of the research team. The credentials of the researchers and their professional experiences enhanced the credibility of the research team to the participants.

3.3.1.1 Multiple data sources

The client requested the gathering of data from multiple districts that were currently implementing one-to-one computing initiatives. Data were collected from districts using interviews and focus groups as well as through an accrual of documents used to support the one-to-one initiative in each locality, such as acceptable use policies, technology plans, procedures for deploying technology, and other related district policies. To further facilitate the collection of data from multiple sources, the interviews and focus groups consisted of people in various positions (including past employees responsible for the genesis of a program), with differing levels of experience and involvement with the implementation. This process of comprehensive data collection provided a broad range of perspectives to inform and guide our findings.

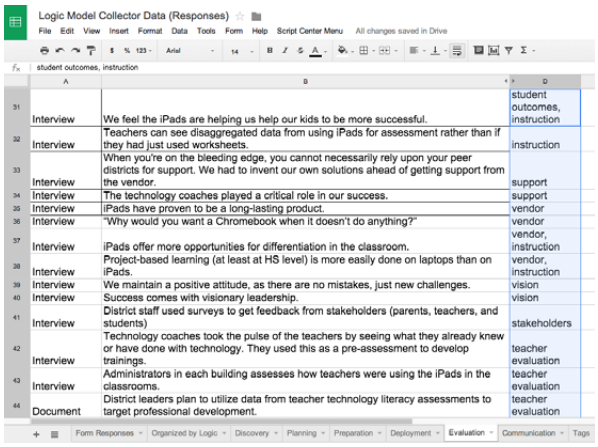
3.3.1.2 Member checks

Participants were given the opportunity to amend or remove any information provided to the researchers during the interview session. The researchers also shared the profile summary of the participating district's journey gleaned from interviews and documents. The profile was emailed to all participants in each district and the participants were asked to send comments within a week. This allowed the evaluators to obtain feedback regarding the quality and accuracy of the data collected by the researchers. We also did this to offer a level of transparency to our data collection process and offer participating district personnel a benefit for working with our research team.

3.3.2 Steps Taken to Enhance Dependability

As a research team, we utilized *Google Apps* throughout the research and analysis process to aid in collaborative editing and study of research documents and to ensure that each member maintained access to the full complement of research documents. Research documents included team notes, which acted as protocol logs (Yin, 2003). These were updated during and after each team meeting and interview session. Research documents also included the digital recordings of interview sessions, of which multiple copies were maintained as "backup" copies. During interview sessions, one member of the team was designated as a note taker. These notes were uploaded into the team's *Google Apps* directory after the interview. The notes were also discussed in post-interview debriefings with our capstone director, with necessary changes made following discussions with group consensus, if needed. Interview recordings were also divided amongst the team members to be transcribed as a method of checking the accuracy of the notes.

We used another protocol log to decide how transcripts from interviews would be color-coded for analysis with themes, using a group-created logic model. The model was developed across several group meetings after all focus group and interview sessions were complete. The model reflected a "best case" scenario on how a district might approach developing a one-to-one computing program. The logic model appears as Figure 5-1 in chapter five. We divided the transcripts by district and read through each one using the lens provided by the stages of the logic model. Each phrase or idea was highlighted with a corresponding color of the stage in the logic model and placed into a spreadsheet (see Figure 3-1). The spreadsheet was organized


Logic Model Collector Data (Responses)

File Edit View Insert Format Data Tools Form Help Script Center Menu All changes saved in Drive

student outcomes, instruction

	A	B	D
31	Interview	We feel the iPads are helping us help our kids to be more successful.	student outcomes, instruction
32	Interview	Teachers can see disaggregated data from using iPads for assessment rather than if they had just used worksheets.	instruction
33	Interview	When you're on the bleeding edge, you cannot necessarily rely upon your peer districts for support. We had to invent our own solutions ahead of getting support from the vendor.	support
34	Interview	The technology coaches played a critical role in our success.	support
35	Interview	iPads have proven to be a long-lasting product.	vendor
36	Interview	"Why would you want a Chromebook when it doesn't do anything?"	vendor
37	Interview	iPads offer more opportunities for differentiation in the classroom.	vendor, instruction
38	Interview	Project-based learning (at least at HS level) is more easily done on laptops than on iPads.	vendor, instruction
39	Interview	We maintain a positive attitude, as there are no mistakes, just new challenges.	vision
40	Interview	Success comes with visionary leadership.	vision
41	Interview	District staff used surveys to get feedback from stakeholders (parents, teachers, and students)	stakeholders
42	Interview	Technology coaches took the pulse of the teachers by seeing what they already knew or have done with technology. They used this as a pre-assessment to develop trainings.	teacher evaluation
43	Interview	Administrators in each building assesses how teachers were using the iPads in the classrooms.	teacher evaluation
44	Document	District leaders plan to utilize data from teacher technology literacy assessments to target professional development.	teacher evaluation

Form Responses | Organized by Logic | Discovery | Planning | Preparation | Deployment | Evaluation | Communication | Tags

Figure 3-1. Data analysis spreadsheet. Data from interviews and documents was coded using themes from our codebook.

with tabs, one for each stage. After collecting all of the items, the research team reviewed each idea and coded it, which resulted in the formation of a codebook. The codebook was then used to structure the writing of the data analysis section. The same protocol was utilized to record the color coding scheme in documents collected from each district site.

As with all the other research documents, the collection of school policies and documents were uploaded and shared with all team members using *Google Apps*. Most importantly, working sessions for the team routinely ended in a summarization of thoughts about the progress of the research process and included any need for changes to the process for future data collection and analysis. Notes were reviewed from previous sessions weekly at each team meeting and progress was shared with our capstone advisor in weekly or semi-monthly meetings.

3.4 Data Collection

3.4.1 Interviews and Focus Group Procedures

At the beginning of each interview, the interview procedure protocol was followed (see Appendices I and J). The research team members introduced themselves and told the participants that the session would be audio recorded but were assured that all personal identifiers would be removed in the final documents. In focus group interviews, participants were informed that the research team members would maintain their confidentiality, but that due to the focus group setting, they could not guarantee other interviewees would abide by this guideline. The procedure also reminded participants that they could request to have their statements removed from the transcripts. Consent forms were given to each interviewee to sign in face-to-face meetings. In interviews conducted with *Google Hangout*[2], participants were emailed a copy of the consent form a week ahead of time. After the consent forms were signed, each member of the research team took turns asking the interview questions. After the interviews, the research team members divided up the audio recordings and transcribed them. All recordings will be destroyed on May 1, 2014, after this report has been finalized.

3.4.2 Interview Participants and Length of Interviews

We conducted interviews and focus groups with personnel from the five districts (see Table 3-2). Due to the longevity of the program in District One, we interviewed many current and former employees: two former superintendents (Superintendent A: the superintendent that began the initiative; Superintendent B: the succeeding superintendent), one technology director, a professional development coordinator, four principals, and five technology coaches. Since the initial implementation, some of the interviewees have taken on senior leadership positions or have left the district. Two focus groups and six individual interviews were conducted through both face-to-face and *Google Hangout*. In both of the superintendent interviews, all four members of the research team were present. The interview on January 27, 2014 with the first superintendent took 49 minutes over *Google Hangout*. The second superintendent was interviewed face to face for 134 minutes on January 31, 2014. Two former

2 *Google+ Hangout* is a synchronous video chat service that can accommodate up to 10 individual users at one time, similar to Skype.

principals were also interviewed individually. All four members conducted the interview face-to-face for 64 minutes with the first principal on January 22, 2014. In the second interview, two members of the research team conducted the face-to-face interview for 44 minutes on January 28, 2014. The former instructional technology director, who during the implementation had the roles of teacher and technology coach, was interviewed over *Google Hangout* for 59 minutes by two members of the team on January 24, 2014. Four members of the research team also interviewed the former director of technology over *Google Hangout* for 49 minutes on January 29, 2014. Two focus groups were also held with the members of this district. On February 3, 2014, three team members interviewed four participants: one professional development coordinator, one high school principal, one teacher, and one technology coach. The interview was face-to-face and lasted 125 minutes. During the interview, one participant arrived about 30 minutes late and left about 30 minutes early. The second focus group took place on February 6, 2014 for 100 minutes with three technology coaches. The focus group was conducted by two members of the research team and lasted 200 minutes.

In District Two, we gathered data through one focus group consisting of the director of technology and innovation, one principal, and five technology coaches. The interview lasted 86 minutes and was conducted on December 11, 2013. After the interview, one follow up email was sent on January 20, 2014 with ten questions without reply (see Appendix K). Informal observations were made by two members of the team in this district on September 18, 2013 and in a subsequent visit by one team member on October 29, 2013.

In District Three, we interviewed eleven people who were instrumental in the implementation of the initiative on December 2, 2013. The superintendent, assistant superintendent of instruction, director of secondary education, two principals, and five technology coaches participated in the focus group interview. One additional, unexpected guest had been invited to the interview by the director of secondary education. This participant was not an employee of the district and he was there to gather information related to his own research project. All four members of the research team conducted this interview lasting 116 minutes. During the interview, the assistant superintendent of instruction left after about 35 minutes. The superintendent left after about 60 minutes and one principal left about 75 minutes after the start of the interview and neither returned.

In District Four, three members of the team interviewed seven participants, all individually and face to face on October 7 and October 8, 2013. The superintendent met with the team for 42 minutes. The assistant superintendent of instruction spent 21 minutes with the team. The director of technology and school administration answered questions for 16 minutes. The coordinator of technical services spent 29 minutes in the interview. The principal responded for 18 minutes and the technology coach spent 20 minutes with the research team. One participant could not be interviewed due to absence. The research team sent follow-up questions to the district on February 13, 2014 in a *Google Spreadsheet* format (see Appendix L). All but one original interviewee responded to questions in the *Google Spreadsheet* and the absent participant responded to the follow up questions.

Finally, District Five participants were interviewed through *Google Hangout* on January 16, 2014. The focus group consisted of the director of technology, one principal, and three technology coaches. All four members of the research team participated in the interview that lasted 72 minutes.

3.4.3 Data Collection Feedback

We were asked by one participant in a focus group to keep one comment "off the record." That detail, which was offered in jest, was removed and not considered in our analysis of our

Table 3-2: *Interview Schedule*

District	Date	Interview participant position at time of initiative	Interviewers	Length of Interview (minutes)	Form of Interview
1	1/22/14	one principal	Deloatch, Hendron, Kim, Tolliver	64	individual face-to-face
1	1/24/14	one technology coach	Hendron, Kim	59	individual Google+ Hangout
1	1/27/14	one superintendent	Deloatch, Hendron, Kim, Tolliver	49	individual Google+ Hangout
1	1/28/14	one principal	Hendron, Kim	44	individual face-to-face
1	1/29/14	one director of technology	Deloatch, Hendron, Kim, Tolliver	49	individual Google+ Hangout
1	1/31/14	one superintendent	Deloatch, Hendron, Kim, Tolliver	134	individual face-to-face
1	2/3/14	one teacher, one principal, one technology coach, one staff development coordinator	Hendron, Kim, Tolliver	125	focus group face-to-face
1	2/6/14	three technology coaches	Kim, Tolliver	200	focus group face-to-face
2	12/11/13	one director of technology, five technology coaches, one principal	Deloatch, Hendron, Kim, Tolliver	86	focus group face-to-face
2	1/20/14	one director of technology	Hendron	N/A	follow up questions emailed
3	12/2/13	one superintendent, one assistant superintendent of instruction, one director of secondary education, two principals, five technology coaches, one unexpected guest	Deloatch, Hendron, Kim, Tolliver	116	focus group face-to-face
4	10/6/13	one superintendent	Deloatch, Kim, Tolliver	42	individual face-to-face
4	10/6/13	one assistant superintendent of instruction	Deloatch, Kim, Tolliver	21	individual face-to-face

Table 3-2: *Interview Schedule, continued*

District	Date	Interview participant position at time of initiative	Interviewers	Length of Interview	Form of Interview
4	10/6/13	one principal	Deloatch, Kim, Tolliver	18	individual face-to-face
4	10/6/13	one technology coach	Deloatch, Kim, Tolliver	20	individual face-to-face
4	10/7/13	one director of technology and school administration	Deloatch, Kim, Tolliver	16	individual face-to-face
4	2/13/14	one superintendent, one assistant superintendent of instruction, one director of technology and school administration, one coordinator of technical services, one technology coach, one library media specialist	Kim	N/A	follow up questions
5	1/16/14	One director of information and educational technology, one principal, three technology coaches	Deloatch, Hendron, Kim, Tolliver	72	focus group Google+ Hangout

data. After sharing our *Case District Profile* for District One, we received comments from the district contact and four interview participants. We also held one follow-up interview and one conference call with two of the participants from District One. We also received comments from one participant in District Two, one participant from District Three, two participants from District Four and no comments from District Five. These comments allowed us to clarify what was shared in interviews with more details.

3.4.4 Source for Documents

We collected the following documents from each district (see Table 3-3). The documents from District One were collected from the district's website as well as provided by employees of the district. District Two employees referred us to the district websites for most of the documents. District Three handed us all of their documents at the beginning of the interview in quintuplicate. An employee from District Four emailed the documents to the researchers. We accessed the district's policy through their website, along with information regarding the one-to-one initiative. Finally, District Five personnel directed the researchers to look on their district's website for the documents.

Table 3-3: *Documents for Data Analysis*

District	Documents
1	Employee Acceptable Use Policy Student Acceptable Use Policy Strategic Plan Aligned to Technology Plan Student Code of Conduct Parent Training Webpage Internet Safety Community Webpage Student Training Webpage Technology Tips for Teachers, Students and Parents Webpage Previous research studies
2	Acceptable Use Policy Computer Use Form for Students and Staff Technology Plan Strategic Plan iPad Parent Meeting Presentation Parent Sign Off form for iPad Parent Acceptance of Financial Responsibility Form iPad Parent Survey
3	Acceptable Computer Use Parent Letter Parent Permission for Students to have Email Letter Student Memorandum of Understanding Parent Acknowledgement Form for Student iPad Use Student Technology Equipment Agreement Educational Technology Plan Strategic Plan, 2010-2015 Instructional Framework for Educational Excellence 2013-2016 Implementation Team Powerpoint Parent Meeting Powerpoint and Handouts Student Handbook Digital Citizenship Student Powerpoint iPad Use Guidelines Lease Purchase Agreement Parent Survey, January 2014
4	Acceptable Use Regulations for Students and Staff Acceptable Use Form for Staff and Students Acceptable Computer System Use Acceptable Use Parent Letter Permission form for Online Accounts Electronic Equipment Loan Policy 1:1 Information Webpage for Community Principal Introduction Letter Technology Plan Parent Night iPad Presentation Teacher Training Presentation Pilot School Survey Results, January 2014 Spring 2014 Instructional Newsletter
5	1:1 Computer Device Policy 1:1 Computer Device Policy - Attachment A (Responsible Use) Chromebook Identification Procedure Webpage Student and Parent Responsibilities Form Content Filter Procedure on Webpage No Expectation of Privacy Procedure on Webpage Operating System and Security on Webpage Repairing and Replacing Chromebooks Webpage List of Softwares on Webpage Guidelines for Taking Care of Chromebooks Webpage Using Chromebooks Webpage

3.5 Conclusion

The methods chosen, and data collected, allowed us to survey the process district leaders undertook in implementing their one-to-one programs. Through the use of focus groups and interviews, we were able to ask specific questions about the challenges and successes of leaders. Our analysis of documentation allowed us to survey the details involved in the one-to-one implementation process, resulting in a broader picture of each case study. Our team championed the use of collaborative, cloud-based technologies to efficiently and securely collect, store, and analyze data used for this research endeavor.

Case District Profiles

Photo courtesy of Flickr user stevendepolo

Chapter 4

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4.1 Introduction

What follows are individual case profiles of the five districts selected for this study. Within each, we present both objective characteristics of the district in addition to details of their ubiquitous computing program. Publicly available data sources, in conjunction with data collected via interviews and documents, were used to generate these profiles.

4.2 District One Profile

District One is located in a suburban county with a population of over 314,000 residents. The economically diverse community supports a variety of businesses that range from agricultural to corporate. The median household income in District One is $61,300 and approximately 30% of households have children under the age of 18. According to 2012 Census data, the county served by District One has a 10.5% poverty level.

District One serves over 48,000 students in forty-six elementary schools, twelve middle schools, and nine high schools. According to the vision and mission statements of the district, the school leaders strive to bring authentic learning opportunities to students so they can become contributing citizens. The strategic plan for the district asserts a commitment to preparing students for their future through the delivery of technology-embedded instruction in meaningful and efficient ways. In addition, the plan calls for an ongoing review of their instructional technology program to meet the needs of students and to align with the district's strategic goals.

4.2.1 One-to-One Computing

According to their website, District One has currently deployed over 23,000 Windows-based laptops across the district's high- and middle schools for the one-to-one initiative. Elementary schools do not participate in the one-to-one program and use computers in labs and in classrooms. Over ten years ago, laptops were deployed simultaneously at all of the district's eight high schools. After the first year, the district's technology team deployed laptops simultaneously to each of their middle schools. Among the five districts covered in this study, District One has both the largest and most mature implementation of ubiquitous computing.

According to Superintendent A who started the program, the district's technology team had created the biggest wireless network anywhere in the world at the time of their initial deployment of laptops to students and teachers. He also told us: "It was really way ahead of its time both from technical infrastructure, content development and really our readiness." The challenges according to this superintendent, however, were worth overcoming due to the gains the district's students demonstrated in achievement, with 100% of the high schools receiving full state accreditation after three years into the program. The superintendent noted that this benchmark was evidence that schools in the district's most economically-challenged areas had made significant gains in achievement during that time.

When asked about the reasons for adopting ubiquitous computing in the district, both current and past employees spoke of a desire to eliminate the digital divide, especially across areas in the district with economic disparity. A former district leader described the disparity: "The reality in a district like ours—haves and have-nots. People generally talked about that along racial lines, which was partially true, but it was more deeply divided around poverty. There is an alignment with race, but there are also poor white families and some middle class African American families." He re-articulated the continual challenge served by the program to eliminate the digital divide. In addition, current and past employees spoke of a district that faced both academic and instructional challenges. Technology was viewed, by former superintendent A, as a means to improving student outcomes. The previous use of technology in the district in traditional labs and with laptop carts in classrooms placed a limit on what the internet-connected tools could do. A survey by the technology team prior to the one-to-one program demonstrated that across almost every one of the district's schools, the computer labs and laptops on carts were being used almost 100% of the time by students. Superintendent A shared with us, that he, along with a team assembled with leaders from across the district, began meeting regularly to plan for ubiquitous computing, based upon the assumption that there was not enough technology to serve every student's academic needs. Under this superintendent's leadership, the team met for nearly two years to plan on logistics, professional development, and financing to ensure the project's success.

A long term goal for Superintendent A was an alignment "of the work students were doing in school to their future." According to this superintendent, the project attracted a $10 billion economic development in the county served by the district, with the assumption that students graduating from the district

would be well-prepared to thrive in the knowledge economy. Many of the current and former staff we spoke to shared positive stories with us about past graduates from this district detailing the impact ubiquitous computing had on their lives. The impact is perhaps best articulated by this story, retold to us by Superintendent A:

About three years ago a reporter from ABC came in to interview me. And he said that you don't recognize me but you were my superintendent and I graduated from [name of school] and I would not be in the job I am today if it were not for the effect [the district] had on me; my brother would not have graduated from [name of university] engineering school, so my mother and father told me to tell you that you had a huge impact.

According to Superintendent B, the only purchased digital content available at the start of District One's ubiquitous computing program was a series of online high school textbooks. Today, the teachers in the district use a learning management system to curate and distribute both purchased and teacher-created digital content to support learning. Students in the district also continue to use digital textbooks. Use of the management system and some textbooks requires Internet connectivity away from home for some assignments, but the district's leaders have negotiated low-cost options for Internet connectivity at home with area service providers since the project's inception.

4.2.2 Recipes for Success

4.2.2.1 Setting a vision

Leadership and administrative support were instrumental in bringing about the changes needed for the success of the initiative. As one former principal stated in his interview:

If you have the leadership that really promotes, really expects, really insists, and really provides the training and the gentle nudges, then we'll see more efforts in the use of technology as a 21st century tool to help our kids become 21st century ready in that regard. So, that's so very important. With that at the central office level as well as at the building level.

One former principal recalled that District One's participation in a ubiquitous computing program came from the vision of Superintendent A who was very hands-on in his approach of bringing devices into the hands of every middle and high schooler. He held weekly meetings with key personnel and was involved in every step of the planning and rollout process. Interview participants still remember the strong leadership and vision instilled by this superintendent. One former technology coach interviewed stated, "Isn't it amazing that [after so many] years later, that four people in a room in various roles since then, can still quote the vision? That speaks to the strength of where we were going; from the top down."

Superintendent B spoke to us about his desire to maintain the vision of the program, despite the challenges resulting from a contentious school board election and turmoil brought about because of negative editorials appearing in the newspaper. Superintendent B used data collected from discussions with, and surveys completed by teachers, students, and parents to bolster continued support for their program into its next "phase," which resulted in a change of platforms at the high school and a lease offering budget savings of about $4 million in their contract.

4.2.2.2 Deployment with staff

During the interview with a former director of technology, he explained that the change process began with the administrators. The district leadership team had a desire for the building level administrators to guide the transformation of classroom instruction. A former director of technology described the process of first providing training to the building leadership fol-

lowed by encouragement for them to begin modeling the use of technology in faculty meetings. He also shared with us that the use of the technology by the administrators was intended to: "Get them more comfortable with what they would expect to see in the classroom." He continued by stating that the next step was to "get the teachers comfortable with the actual device."

District One deployed the devices to their high school teachers one month prior to providing them to the students. The middle school teachers received the laptops the spring before the students. One of the technology coaches interviewed shared: "[the superintendent] said 'go home, use it for email, use it for banking, use it for whatever you want to use it for, so get in with the machine,' so I think it helped with the level of comfort of the teachers." A former instructional coach shared this perspective on supporting administrators and teachers in using technology: "We were really big on developing… all the different plans on how we were going to teach the students and how to teach the teachers on how to use the computers. And part of the reason I was brought into staff development was that I spent a couple years before the one-to-one initiative teaching administrators how to use computers." Her role had previously included teaching administrators on Internet basics in a dedicated computer lab for professional development.

District One leaders recognized the importance of having instructional resources available for their teachers as part of the instructional program that was developed in concert with ubiquitous computing. The instructional program was referred to internally by staff as "eLearning." One of the former technology coaches interviewed referenced eLearning as a tool that teachers used to share ideas and models of technology use: "We had a virtual share folder, a thing we created where all the teachers could drop in lessons and share things back and forth with students, so then it became more and more interactive." Early in the program not many resources were provided beyond digital textbooks for teachers so they were required to create their own instructional materials, which could be shared via the "virtual share folder." As the program developed, district leaders did work to provide instructional resources and services as they became available from vendors.

4.2.2.3 Technical support for students

Simultaneously, District One began recognizing the need for technical assistance to support the initiative. A former principal interviewed stated:

It was understood that students are going to have issues and need some support and that the help desk was the place that they could take their computer to have the tech person look at it and reboot it, or figure out what had gone wrong. Just help them solve problems. I can remember thinking that it was a pretty good business for the computer business because the UPS guy visited every day and took away computers that needed repairs and brought them back and it seemed like a pretty good business for them to me.

A former principal shared that a technology staff member manned the help desk, and then it transitioned to a point where support was augmented by teachers and students who were "well informed computer users." He continued by sharing:

We grew to a point where some savvy eighth graders could help out. They might be the person at the desk to log in a computer that a student brought. They might not be the technical person that looks at it to fix it but they could help manage the housekeeping kinds of things, the check-in, check-out or, and probably there were some students who had enough knowledge that they could say, 'Did you try this or did you try that?' kind of thing.

A former instructional coach shared the benefits of the help

desk and loaner computers. She told us, "We had a help desk in place, and a supply of loaners, so every child would have a laptop in the classroom, and if one was broken they could get a loaner." As we learned through interviews, each of the district's middle and high schools still have help desks set up today to assist students and staff.

Superintendent B shared details about the supply of loaner laptops as part of the procurement process of the second phase of the high school deployment: "It was supposed to have a five percent [supply of loaner laptops] on top of what we already had there; machines would come and we'd exchange it out whenever they wanted to. But if a laptop went down, I expected when it went to the help desk the kid would be given another laptop if it was more than a five minute repair." According to Superintendent B, an internal laptop repair data report prepared into the third year revealed that there was a eight to ten percent repair rate across the district. The same report also showed that up to 30% of the students in certain schools were not reissued laptops due to the inability for the families to pay the repair fee. As a result, district leaders eliminated the repair fee so all students could continue to have access to the technology.

4.2.2.4 Parent orientation

District One modified the acceptable use policy (AUP) as well as the student code of conduct at the start of the program. Throughout the years, both of these documents went through several more modifications to reflect the current needs of students and staff and the rise of social networking, according to school personnel we interviewed. These participants commented on the importance of parent training and the methods in which staff have been training parents since the initiative began.

At the start of the program, District One leaders required parents to visit each school to participate in training and orientation with their child. Today, this process has been streamlined, and parents complete an online training course accessed through the district's website before students receive laptops. A district staff explained that one of the reasons given for the availability of web-based training was that today "we have better-informed parents [about technology use]." Alternatively, parents can complete the training online at a school library or during a scheduled face-to-face meeting with the school's technology coach. At the end of the video training course, parents take an online quiz and the results are automatically sent to their child's school. Also on the parent webpage are links to parent laptop study guides, technology tips on keeping students safe, and even a tutorial on how to hook up home printers to the student laptops. The AUP and student code of conduct are also available on the webpage.

4.2.2.5 Professional development

Providing professional development to staff members was an ongoing part of the culture for District One as shared by those interviewed. The introduction of a one-to-one initiative provided the district's professional development staff a new direction of focus for teacher and administrator training. Superintendent A explained that one key focus of the weekly meetings he held with principals and other leaders was to plan for the instructional paradigm shift that would facilitate a change in teacher pedagogy. During an interview with Superintendent B, he commented that "hands-on professional development was fundamental to the success" of the one-to-one initiative. However, the district faced other instructional challenges such as improving standardized assessment performance and addressing special education and English language learning issues. The challenge, as explained by Superintendent B, was to tie the technology into the instructional professional development already in place.

Superintendent A explained to us that the district leadership's commitment was to provide ongoing growth opportunities for all employees, especially to support the one-to-one initiative: "By dedicating professional development in real time sent a message to employees that we really do value your learning and know that this is an investment we have to make." He continued by detailing the range of recipients that benefited from the professional development such as administrators, principals, assistant principals, central office staff, teacher leaders, and aspiring leaders. He continued by stating: "I think the scope and the comprehensive approach to PD…all of that continuum, was aligned with the [...] initiative."

District One not only provided innovative professional development options, they also personalized the training to participant needs. Summer workshops, where teachers were paid for the training time, were used at the start of the program to efficiently prepare teachers for teaching with new technology. Superintendent A described in his interview how the professional development opportunities were structured: "We set up the summer institutes and developed course offerings [so] that teachers could select courses that were germane to their immediate needs. So they were aligned [to what teachers needed]. Some were technical (foundation), others were related to content areas [and] collaboration." During an interview with a former principal, he described his professional development experience as it related to the one-to-one initiative: "It was a wide range and it was all centered around [results from] surveys that were given where teachers had the opportunity to provide some input in terms of what they needed and where they were. Were they novice? Were they middle of the road? Were they high flyers? And the district made every effort to try to match things up to the summer institutes."

Online training options for teachers were offered in the second year of the initiative. According to one of the district's former technology coaches, online courses were developed by the district's professional development staff on a variety of topics relating to "eLearning," chosen by input from teachers and technology coaches. These courses supporting the idea of staff being able to access professional development anytime they needed it instead of waiting to sign up for a class.

In addition to the professional development provided by the district's own staff, the district has used training provided by laptop and software vendors. Superintendent A recounted: "As a matter of fact [as] part of our contract with [the laptop vendor], they did [provide professional development]. They came in and did a lot of the initial training. As a matter of fact, you may remember they put together these lunch boxes they called toolkits." This resource was provided to teachers who were part of the one-to-one in an effort to provide them ongoing training and support.

One of the technology coaches we interviewed described the initial training by one vendor for technology staff to be more technical to support the laptops administratively. With the second vendor the district now uses for laptops, training is focused on instruction. As part of the lease agreement with this vendor, they provide consultants who have delivered "train the trainer" support, where district personnel provide the training directly to teachers.

4.2.2.6 Developing community support

District One staff recognizes the importance of communicating goals and visions with the community. Because of the program's novelty, the initiative caught the attention of the media at its inception, and stakeholder opinions were formed. More than one district leader from our focus groups underscored the importance of including the media in all communications about one-to-one programs. According to the district's website, they use a community access cable television channel and employ a director of communication to manage their perception with the community. As shared by Superintendent B, when the

opportunity became available, he made a strategic decision to hire a director of communications who was highly skilled in public relations. After the third year into the program, a survey was sent to parents to measure their perception of the program's success. The survey, described by Superintendent B, received a 90-95% response rate from students and staff and a 60-70% response rate from parents. The survey results indicated an overall positive response for the program. A former technology director interviewed described positive comments made by students and parents regarding the program as a show of support by the community. He said, "If I was able to help one family and student, I think it was successful. Because I know I walked into a lot of schools and I know I heard a lot of students tell me they really appreciated us doing this."

One interviewee stated some parents complained that they did not understand why laptops were necessary for learning when "paper and pencil was how they learned." One way to demonstrate to parents and community members what one-to-one computing looked like was through the community access cable channel. The district began showcasing students using the devices in classrooms by featuring classroom lessons. One participant described the television show as a public relations strategy: "We wanted the parents to see what we were doing with the laptops." The constant exposure to the community of students using technology was a good method of helping change community perception of teaching and learning. The participant continued: "That was huge, to get the whole community and the parents beyond a chalkboard, when I look at that... especially this community... we had a lot of long conversations with parents." Beyond television, public relations were further enhanced through engaging parents through person-to-person dialogue. According to Superintendent B, involving the parents and community in the planning for the continual growth of the one-to-one program was a necessary step for strengthening and maintaining their support.

4.2.3 Measuring Progress

Several of the District One personnel we interviewed spoke of the need for assessment tools being put into place prior to and during the first few years of implementation of the district's one-to-one initiative. From the perspective of one former technology coach, he was unable to identify "long term data gathering attempts" during the early stages of the implementation. According to Superintendent B, he felt it was important to assess the success and needs of the district staff in terms of the one-to-one implementation. When he came to the district, he explained how he was asked repeatedly by community stakeholders to show data which proved the success of the initiative. He felt that the best way to accomplish this was to start with obtaining feedback from staff members. He pulled together over 260 school personnel from across the district to discuss the pros and cons of the program and what the district needed to do moving forward. There were representatives from all schools including teachers and administrators. After receiving the input from the staff, the school board was also asked to provide their input. In addition to gathering information from staff members and the school board, six different parent meetings were held across the district to gather their input. According to Superintendent B, a common set of questions were asked during the meetings with staff and parents: "What's working with the technology? What's not working, and what do we need to fix so it works better?" An additional question that was asked of administrators and teachers was: "What questions do we [need to] ask parents and students to support this initiative?" The results of this process led the district personnel to solicit bids for an externally-managed survey. The survey questions were developed based on the input from students, staff, and parents, according to Superintendent B. The District One leadership team used the data from the survey to determine what was needed to structure the next phase of the one-to-one implementation, which led to the change in laptop vendor.

In addition to surveys given to parents, teachers, and students, the district has also participated in several research studies. One was funded as part of the purchase agreement with the vendor that examined their ubiquitous computing program. Others came in the form of doctoral theses. One study, in particular, examined the impact laptops had on mathematics and science instruction. Today, in addition to trying to measure the effectiveness of the one-to-one initiative, the district also solicits a more regular study focused on district climate. Several district leaders also focused on the one-to-one program in their own doctoral dissertations, through a diverse set of research perspectives. While we had access to some of these studies through our interactions with district personnel in focus groups, we cannot discuss the results explicitly while maintaining their confidentiality. The results of the studies we were told, however, were used in making strategic decisions around professional development, improvement in instruction, and communications with parents and community stakeholders.

4.2.4 Challenges

4.2.4.1 Focus on infrastructure

The initial deployment of laptops was a story retold many times in our interviews, with the initial challenge of not having enough bandwidth and wireless saturation to support so many laptops at one time. The challenge of bandwidth was often illustrated by those we interviewed as having "a straw" to the Internet when teachers and students required a "firehose." When we asked in our interviews about what others considering one-to-one programs should focus on to prepare, "infrastructure" was a common response. Some of the challenges District One personnel faced were due to the immaturity, at the time, of wireless networking. When we spoke to the former technology director who helped deploy the initial set of laptops, he shared with us that they had set up one high school as a test area for deploying new networking equipment and wireless access points to test before replicating the same setup in other schools. This concept of starting small and scaling up was echoed in his current ubiquitous project in another district. In that district, they are deploying laptops slowly over a period of years, staggering the installation of equipment, the training of teachers, and the access to students. He told us the approach used in District One was not wrong, but "we were making the best decisions back then—with [the] information and equipment we had."

4.2.4.2 Filtering and student expectations

Another challenge that came to light during one of focus group interviews with current staff in District One was the state of filtering and student discipline issues with accessing inappropriate content and gaming. The initial deployment of laptops to high school students did not include any local security on the computers, and filters had not yet been configured at the schools. Language used when training students, in hindsight, the interviewees shared, could have been more direct about expectations for how laptops were to be used. Staff at the time highlighted the positive educational benefits, but had not spoken explicitly about issues relating to "digital citizenship" or "Internet safety." After several months, when filters were put into place across the district, students still managed to gain access to inappropriate content using their home Internet connections. The administrators in our focus group shared their frustration of having to figure out how to punish students for coming to school with inappropriate content on the laptops, specifically with decision making about how severe the punishment should be.

Despite the initial problems with some student misbehavior with the laptops, changes to security settings, filtering, and more importantly, stronger student expectations and policies enacted through their code of conduct, have deterred most problems for the staff we interviewed. They shared with us that "bad classroom management is amplified with technology,"

and one solution is for classrooms to re-position desks and tables to make supervision easier by teachers and for student screens to be visible by teachers at all times. Professional development efforts later in the program focused on classroom management strategies for teachers with ubiquitous computing. Today the district has relaxed their filtering policies, relying upon classroom management strategies to ensure appropriate use of the Internet by students.

4.2.4.3 Changing platforms

After the initial deployment of laptops in District One's high- and middle schools, a renewal procedure of the technology lease used to fund the laptop purchase led to a switch in laptop vendors. Initially, the choice of platform was made with a lens on utility and quality, but Superintendent B revealed in his interview that the district's procurement office was requiring a change in how future technology must be obtained. The district was no longer able to utilize a "sole source" provision, and he had to put out to bid a request for continuing the one-to-one program. Some board members were concerned with leveraging a lower overall cost on equipment, while at least one board member was against continuing with the program. Superintendent B shared with us that he had organized a committee of stakeholders, including many teachers, who were charged with analyzing survey data and financial projections for continuing with one vendor, or switching to another. He told us that the committee he had organized made a unanimous conclusion to switch vendors, which would save the district $4 million. The school board accepted the recommendation and in the next school year, the district's high schools had new laptops running another operating system.

According to some participants we interviewed, the switch of platforms was viewed as a mistake in the district's history with one-to-one computing. For example, a former technology coach we spoke with in a focus group interview offered his own interpretation, undisputed by other members of the group:

> *If you had asked me—and I would still say this—I think it was a terrible decision. I think it was the wrong one, in fact. And I would say that this was an example of something we did not do well. We lost a year, maybe more probably, two [years] of [professional development]. You now think about all of the hardware we had done, for four years and pushed, and tried to get everything done in a certain way. And even if the [original platform] wasn't the best platform for what we had experienced in the quote 'real world'… We had done so much in learning with the teachers and [with] the students. To go backward was to almost start over again, in a sense, it was damaging to the work that had been done.*

4.2.4.4 Finding direction

While the district has continued with its ubiquitous computing program and is currently piloting tablets in an elementary school, we discovered in our discussions with both past and current employees that the rationale for supporting the program had shifted. In an informal discussion with a past assistant superintendent of instruction, she shared with us one of the original instructional goals for the program: improve writing and research skills. More than one interviewee suggested the rationale was tied to preparing for new state standardized testing. When asked specifically what style of teaching was being targeted, interviewees had a difficult time naming one pedagogical model as part of the district's vision. One former technology coach indicated that there was a focus on school-based training. Likewise a former principal indicated that teachers were targeted regarding their pedagogy, based on where they were. Benefits were often cited as a rationale, but these were unexpected benefits of the program: reductions in discipline issues and improved school attendance. One former principal we interviewed discussed instruction as:

Increased synergy between student-centered activities; more collaboration, as well as additional training enhanced tremendously; not just the tool, but also how we delivered instruction. [It was a] transformation from paper to a digital world. It caused us to change in our delivery—to do more things for students—a situation with kids availability of 24/7; a great equalizer for the district—you didn't have to be affluent to have the tool and have similar learning experiences—great equalizer. Some classrooms moved away from rows [of chairs] and opened up [with] sharing and discussion.

Many of the current and former staff we interviewed in District One, shared the emphasis at the time, that the technology be used. This was well articulated by a current employee: "[The superintendent had set] the general expectations that we would use the machines on a daily basis." Superintendent B shared with us that some high- and middle-school students he regularly met with during his first year in office reported to him that some teachers in an attempt to appear to utilize the technology on a daily basis, would ask students to place their laptops under their desks. "Some teachers had the kids cut-on their computers, leave the lids open, and put them under the seats so it looked like they were using the technology for [central office]." He believed these teachers suspected that the technology department was using remote monitoring to track laptop usage.

In some cases, the use of external studies and surveys came to light in connection with inquiries around the direction and vision for the program. The survey questions given to students and parents during the first few years of the program, however, addressed instruction in very general ways. Survey questions centered around how many lesson plans targeted the use of laptops, how many students had their laptops in school each day, and for what percentage of class were the laptops used.

In-house district documents shared with us showed evidence of a vision for instruction through the requirement of school-based technology integration goals beginning in the second year of the program. Current staff we interviewed articulated that the vision during the initial deployment year was concentrated on providing all students with Internet access and a tool to help them achieve on state tests. Over time and through changes in instructional leadership, the priorities and focus of the laptop initiative and professional development needs changed. Today, the district has a much more focused vision for instruction with technology for both its elementary and secondary schools. Professional development and a special initiative focused on collecting model lessons promote quality instruction through four sets of twenty-first century skill charts: research and information fluency, communication and collaboration, critical thinking and problem solving, and creativity and innovation. The charts depict each set of skills along a continua beginning with what entry-level experiences will look like. This instructional vision is communicated via the continuum charts to illustrate, by way of descriptors, what ideal instruction looks like across each of the skill groups from both teacher and student perspectives.

When asked who was responsible for creating, and communicating, and assessing the vision for instruction with laptops, both past and present employees often cited the superintendent who started the program as the visionary leader. When asked specifically who was presently assessing the quality of technology integration, current employees told us no one position was tasked with assessing its effectiveness. They cited positions that had previously had the role, or should have the role, although those positions have either become vacant or eliminated due to budgetary constraints. They shared with us that curriculum specialists, technology coaches, principals, and teacher leaders were each responsible for maintaining the quality of instruction. Both teachers and principals contribute to the evaluation

of model lessons the district publishes each year, according to employees in one of our focus groups. They added that budget cuts over the past five years had diminished leadership roles, preventing oversight of the one-to-one program as a specific leadership responsibility.

4.2.5 District One's Implementation Compared to the Literature

Many themes that emerged in our focus group, and one-on-one interviews with former and current staff, likewise appear in the literature. These include the critical importance of quality professional development for both teachers and administrators (Donovan et al., 2007; Fogary & Fitzpatrick, 2013; Hernandez-Ramos, 2005; McKeeman, 2008; Peck & Sprenger, 2008, Penuel, 2006, Potter & Rockinson-Szapkiw, 2012; Schwab & Foa, 2001; Wang, 2000), the time needed for planning for the initial deployment (Sandholtz et al., 1997; Sheingold & Hadley, 1990), the importance of engaging the community for support (Murphy et al., 2007), assessing and improving the capacity of the network infrastructure at schools (Dunleavy et al., 2007), in addition to initial benefits of one-to-one programs: reductions in discipline issues and increases in student attendance (Kereluik, Mishra, Fahnoe, & Terry, 2013). The district was clear in its desire to reduce the community's digital divide (Zardoya & Fico, 2001). While the dynamics that illustrate a digital divide are often in flux, almost everyone we spoke to agreed that the one-to-one program helped make significant inroads towards reducing the divide among families across the suburban county served by the district. In general, students in the district had early positive gains in student achievement, as evidenced by performance on state achievement tests, however, this in not necessarily attributed to the one-to-one program.

The instructional vision currently in place within the district is congruent with other instructional goals by districts starting ubiquitous computing programs, specifically for classrooms that are student centered (Bransford, Brown, & Cocking, 2000; Dunleavy, Dexter, & Heinecke, 2007). Initially, though, the district's vision was to close a digital divide subsequently additional instructional views were identified such as a desired increase in writing scores.

The district's current description of so-called twenty-first century skills as part of its expectations for instruction is likewise congruent with the literature (Partnership for 21st Century Skills, n.d.; Rousseau, 2007). We sensed disappointment in one focus group interview with current employees that more project-based approaches were not as ubiquitous as the technology (Short, 2011; Sockman, 2007). Despite the ongoing challenges associated with teacher change, however, the current employees relayed that they had, in fact, accomplished a great number of positive things during their years involved with the program. A former technology coach was candid: "I think inspite of the awards, the missteps, and the problems and things we did wrong, [that] this is an amazing, incredible thing that we have done. That's one of the reasons why I left the classroom and said 'Wow, that's something amazing and I want to be a part of it.' It's just amazing… when you take a step back and take a look at it."

One interviewee who is currently a secondary principal, shared with us sage advice that was confirmed in the literature for districts considering or beginning their own ubiquitous technology programs: consult with other districts who have already implemented one-to-one computing (Cavanaugh, Dawson, & Ritzhaupt, 2011; Chandrasekhar, 2009). Many of the past and current staff we interviewed remarked that their journey with ubiquitous computing was a deep learning experience, and there was value in their story for other schools starting out.

4.3 District Two Profile

District Two is located in a rural county that once had a thriv-

ing textile and manufacturing economy with a population of over 56,000. The median household income is $34,373. The district serves just over 7,000 students with two high schools, two middle schools, and ten elementary schools. According to its website, the district's on-time graduation rate is 88.3% and its operating budget is ~$70M annually. The school district's vision includes the following: "where critical thinking is expected, creativity is nurtured, technology and innovation are embraced, and learning is celebrated." The district is described in the strategic plan as "a high-performing school division, [that] provides all students with an exemplary education in a safe, supportive environment that promotes self-discipline, motivation, and excellence" through its mission statement. According to the plan, one strategy used by the district to fulfill their vision and mission goals is by using "innovative and cutting-edge technology" by "encouraging the application of technology to enhance instruction and promote innovation."

In 2010, District Two's leaders and teachers started what they describe as the state's largest iPad initiative to date. Today, students in grades three through six take iPads home as part of the district's one-to-one computing program. In addition, a select group of high school students are using MacBook Air laptops that they can take home. These students participate in a special project-based academy at one of the district's high schools. As part of the NewTech Network, the academy's staff have received professional development for innovative learning with project-based approaches.

4.3.1 One-to-One Computing

District personnel began their exploration of one-to-one computing in 1998-99 with take-home privileges of Apple Newton eMate mobile computers for students in grades four and eight. They continued this practice for a second year, expanding to grades five and nine. During the two decades between the deployment of the eMates and the more recent deployment of iPads, teachers and administrators developed experience with technology in classrooms with traditional labs using both laptop and desktop computers. Technology staff, including technology coaches, identified their early experience with students taking technology home as beneficial in their own planning for their iPad initiative. Part of that experience was enlisting the assistance of students with a natural affinity for technology in helping to maintain the technology in working order, and to assist others with troubleshooting, when needed. A principal we spoke to underlined the importance of teachers being able to trust students enough to allow them to help teachers and others students use the technology.

An instructional coach we interviewed said that the iPads have "opened doors for teachers and kids." Personnel interviewed reported that teachers in particular disliked sharing laptops available on carts with one another, as the laptop carts provided logistical distractions. With iPads, where the responsibility is on students to make sure the iPads arrive to class charged, interviewed personnel reported that teachers are far more likely to plan and execute lessons that take advantage of the available technology. Students in the district's schools still use laptops and iPads on carts in grade levels not yet participating in the one-to-one program. When funding becomes available, the district's technology director would like to expand their K-2 deployment of shared iPads on carts to a one-to-one computing opportunity. She plans on expanding the iPad deployment through grade eight in middle school. Additionally, she would like to expand the laptop program at the high school beyond their New Tech academy and offer laptops to all high school students should new funding become available.

District Two personnel consider their one-to-one program a success because it was driven by their curriculum. They stated that the most obvious evidence of this success is increased student engagement in the classroom, especially with special education students. District personnel we interviewed reported to us that many special education students demonstrated sig-

nificant gains in student achievement after using the iPad for a year. They cited that the ability of these students to have a more personal learning experience with the iPad was because it was something they used every day and could take home. Another success cited was independent learning by students. District personnel reported to us that their teachers witnessed students more willing to learn independently, because they had reliable access to the Internet, and because the iPad spawned student engagement. In 2010, the school district's leadership took advantage of a pilot program funded by the state's department of education to explore digital textbooks on the then-new Apple iPad at the same time they were working on updating and refining their curriculum. The provided funding supported purchase of the iPad hardware and the exploration of digital texts from a number of publishers. According to the district's technology director, their superintendent augmented the state funding to expand both the number of devices they could deploy to students and the textbooks they could load onto the iPads. This local funding came in the form of stimulus dollars earmarked for special education, technology, and local uses. The district is now exploring a lease program for the next school year to both sustain and build the program in the absence of federal and state economic stimulus grants.

District Two's elementary students use the iPads in grades three through five with digital textbooks for all subjects. In addition, the district's technology coaches report that they continuously integrate curriculum-based apps on the devices. The technology coach at each school reported that they determine what apps get installed based upon teacher suggestions at that school and that they are responsible for purchasing and installing the apps on student iPads. All of the personnel we interviewed expressed agreement that it is important to install a variety of apps that cover the same curriculum areas, to accommodate the different modalities of learning students may prefer. According to the district's technology director, the cost for apps is primarily handled through each school's parent-teacher organization.

4.3.2 Recipes for Success

In reading documents provided by the district's technology director, and in analyzing the transcripts from our interview with district personnel, we found five components to the rollout that emerged as necessary for continued successful deployment of one-to-one technology.

4.3.2.1 Support of community

District staff cited the importance of having the support of parents and other community members as a significant requisite for one-to-one programs. District Two's technology staff made concerted visits with the county's board of supervisors, economic development leaders, and the district's school board to clearly communicate the educational possibilities of learning with iPads. Visits included training time so these specific leaders could use the same textbooks and apps that students were using in the classroom. According to a survey sent to parents in the spring of 2013 with a 76% return rate, parents responded favorably about District Two's iPad program. Parents reported that they want their children to have this technology to support learning, especially since buying such a device independently is out of reach for a number of families. The following are a summary of results from the survey:

- 51% of the 1,258 parent respondents reported having used one or more apps on the student iPad.

- 60% of parents had looked at a digital textbook on the student iPad.

- 69% of parents reported that their child had an iPad or computer at home prior to receiving the iPad from school.

- 85% of parents reported that their child is more excited about using digital textbooks; 13 % reported "no difference."

- 70% of parents reported that their child is more likely to com-

plete homework and study when content is on the iPad.

• 76% of parents reported that they had access to the Internet at home, yet one comment was to "not give homework that requires Internet."

4.3.2.2 Instructional and technical support

Personnel we interviewed in District Two emphasized the importance of having both instructional and technical staff in place to support a one-to-one program. One of the technology coaches we interviewed communicated that District Two's technical and instructional staff work together in a climate that emphasizes the instructional needs of students over purely technical concerns of iPad management. During the last school year, technical staff updated the district's servers to provide on-demand media streaming, in addition to upgrading the local-area network (LAN) at the district's high schools to support a bring your own technology program (BYOT), according to their strategic plan.

4.3.2.3 Responsible use and insurance

Before the iPads can be taken home by students, parents are required at the start of each school year to attend a training session and meeting at their child's school. Parents are required by district policy to pay a non-refundable insurance fee each school year to cover the cost of replacement. The insurance program covers everything but theft, and the district pays one half of the $48 fee, reducing the burden on each family. iPads are returned at the end of the school year, and parents will be charged a replacement cost at that time if the iPad or its charger are not returned. During our focus group, district personnel commented on students "rising to the challenge" of caring for their iPads with very few incidents of loss or maltreatment.

4.3.2.4 Professional development

District Two relies upon the expertise of their technology coaches to design and deliver the needed professional development for teachers to support learning with iPads. Professional development is provided through in-classroom modeling, through the maintenance of online websites for just-in-time learning, and through workshops held both during the school day and after school. One technology coach reported that she conducts more training after school than during school, and that training held during the day is often reserved for external trainers. The technology director felt that workshops held beyond teacher contract hours at the conclusion of the day are not conducive to significant learning for teachers, so she values the training opportunities they can offer during the day when she pays for substitute teachers to cover the classes for teachers being trained. The technology coaches we interviewed emphasized the importance of personalizing professional development based upon the learning styles of different teachers. For example, while some teachers adopt what is presented in a workshop setting well on their own, others want a coach in the classroom. More independent teachers will ask questions through instant messaging services of the technology coaches for just-in-time support. The District Two technology coaches place an emphasis on keeping teachers outside of a frustration zone. To achieve this, some of the coaches will plan and practice lessons with teachers in advance of delivering the lesson to the students to ensure that the instructional goals are flawlessly supported with technology. One technology coach commented during our focus group: "[The teachers that] had the most success [are the ones] who want to go in and practice or rehearse it first with the technology."

Current professional development efforts this school year focus on teachers being able to create and distribute their own digital texts using Apple's *iBooks Author* software for Macintosh and Apple's *iTunes U* online. District personnel articulated a need for more than the five technology coaches specified in the technology plan to help deliver and support all the professional development the district's teachers need.

4.3.2.5 Administrator support

The District Two personnel we spoke to all agreed that an ingredient for success with a one-to-one program is administrator support. The district is now in its second year of using iPads with building administrators to support teacher observations and evaluation using a product called *Observation 360*. In the pilot year of this product's introduction, the superintendent and other central office staff suggested principals use the new tool to evaluate teachers. In their second year, the suggestion has been upgraded to an expectation. Personnel we spoke to have noted a marked decrease in the use of pencil and paper by administrators, as they are using their iPads for observations and modeling its use in meetings.

4.3.3 Continually Assessing Needs

The district technology plan outlines that to support the goals of digital learning and technology-rich classrooms, the district must support a high-speed infrastructure and provide and utilize a variety of resources to support learning beyond the iPads. These include subscription services that support the curriculum, a *Moodle* server, *Edmodo*, flip cameras, science probes, *iTunes U*, *Safari Montage* media streaming, *Smart*-brand interactive whiteboards, *Mobis* classroom responders, and so-called "Web 2.0" resources such as blogs and wikis. According to the district's technology plan, both technology and instructional staff use a number of data sources to monitor the organization's progress towards their strategic goals of digital learning and professional development for the support of technology-rich classrooms. These sources include student testing data, attendance records of professional development events, conference registration sheets, bandwidth usage reports, teacher observation and monitoring, participation of student work on projects, and usage of online services.

4.3.4 Challenges

The biggest challenge cited by District Two personnel we interviewed regarding the iPad initiative was how to best manage Apple's iPads with the vendor provided tools. Software the district is currently using to manage the iPads was not available in 2010, and the tools today include mobile device management (MDM) software by a third party other than Apple. This class of software empowers technology staff to track to whom each iPad is assigned, poll the device for what software (list of apps) is currently installed, and apply rules for controlling what students can and cannot access through the iPad's settings. The principal we interviewed in our focus group also cited a challenge with a teacher's fidelity in using the device as "making sure that [the teacher] is using it, implementing it with fidelity and using the instructional piece and it is not just a glorified chalkboard for [the teacher]. That was my challenge in my position. And I felt like it might not have been embraced initially but we took baby steps in getting us there." She has witnessed many teachers grow professionally in using the iPads in the classroom with students, to the point where they are now used regularly. At the initiative's onset, the iPads may only have been used for a portion of the day, or inconsistently across a week. The principal did not cite examples of what this looked like, but in a tour we received of the school, we did witness student use of iPads in every classroom, in addition to use of interactive whiteboards to aid instruction by teachers. Continuous professional development was cited by the technology coaches we interviewed as an element that helps develop teacher comfort with the new tool, and the fidelity of its use in the classroom.

4.3.5 District Two's Implementation Compared to the Literature

Contrary to the review of literature on one-to-one computing, personnel in District Two did not immediately report a desire for constructivist-style learning in the classroom as a primary goal for their one-to-one implementation. When probed during our focus group, two of the district's personnel we interviewed men-

tioned an inclination for the project-based pedagogy employed at their project-centered high school academy to trickle-down to the middle- and elementary schools. While this desire was articulated during the interview, we did not encounter evidence to support this change in pedagogy at the elementary or middle school level in the district's planning documents.

When we asked district personnel about the ideal lead time required to prepare teachers for the deployment of devices in a one-to-one rollout, they cited three months as an ideal time frame. District leaders deployed iPads to teachers three months ahead of the students and conducted professional development workshops in the summer before student deployment. Recommendations from the literature advise an advance deployment of technology to teachers by one full year. The personnel we interviewed reported that their head start with technology in the 1990s adequately prepared teachers for the iPad initiative, negating any period longer than three months for training.

The district's technology director reported favorable test scores, among the highest in the state during the last Spring administration of the state's standardized assessment for mathematics, to use as evidence for the success of their program. The principal included in our focus group also cited an anecdotal acknowledgement of student engagement as a hallmark of the program's success.

4.4 District Three Profile

District Three is located in a rural county with a prosperous agricultural economy. According to the district's website, over 5,500 students are currently served through two high, two middle, and five elementary schools across two townships. All nine schools are fully accredited by state standards and the school system has an 87% on-time graduation rate. The pupil to teacher ratio averages 19:1 among the three grade bands: elementary, middle and high. The average expenditure per student is $9,796. In the district's strategic plan, the vision is "to provide rigorous and engaging learning experiences that ensure student success." The school system's mission is

to provide rigorous, academic programs in a safe school environment that fosters high levels of student achievement. The division is committed to offering educational programs characterized by high academic standards that prepare students to exceed state and national accreditation standards. The curriculum will prepare students to be lifelong learners for the ever-changing global economy.

As stated in the first goal of District Three's strategic plan, the district seeks to increase academic achievement by extending "the existing curriculum beyond the [state standard] requirements to provide an enriched learning environment for students of all levels." Congruent with this goal, District Three started its one-to-one computing program during the 2012-2013 school year. All students in ninth through twelfth grades at both of the district's high schools received an iPad for classroom and home use. Additional goals outlined in the strategic plan include increasing student engagement, facilitating collaboration, and providing students with the skills needed for post-secondary education.

4.4.1 One-to-One Computing

At the start of the 2012-2013 school year, District Three's central office staff and technology coaches implemented its one-to-one initiative with 2,000 iPads which were distributed to all high school students. Prior to the one-to-one program, students used both laptops and mobile devices (iPods, iPads) kept within schools on carts. There were two major obstacles identified by the county representatives with this format: lack of network infrastructure that limited speed and reliability of wireless connections and the lack of accessibility and availability of the carts. The number of carts varied at each school based on the size of the student population. One of the technology

coaches we interviewed stated her school had just one iPod cart and six laptop carts each consisting of 30 units that had to be shared among 40 teachers. A second technology coach reported her school laptop to student ratio averaged around one device for every seven students.

For the iPad deployment, the superintendent signed a three-year lease with Apple costing $1.4 million spread over three years. She said that the decision to move to one-to-one allowed the district the opportunity to "level the playing field and to give everyone access, anytime, anywhere." The district's leadership team chose to deploy the iPads to the high schools first because of the requirement for on-time graduation rates imposed by the state for accreditation. Without ongoing technology experiences, the addition of new technology-enhanced items (opened-ended, interactive questions) on the state-mandated assessments could negatively impact high school students' ability to earn the required verified credits for graduation. The selection of the device was based on its lightweight design, the various digital instructional resources available, and the teachers' past positive experiences with Apple technology.

There were several key factors mentioned in our focus group with District Three personnel that facilitated their one-to-one program. The first was the superintendent's ability to secure the necessary funding for the one-to-one initiative. She decided to utilize the monies provided by the state for textbooks to help fund the program. This strategy lessened the amount of money needed from local sources. State regulations permit any district personnel to spend state-provided textbook monies on mobile technology for the purpose of deploying digital textbooks to students. The superintendent shared with us that she received criticism for using the state funds to purchase the iPads, as the public did not understand the state regulations: "That money is locked into textbooks only. I could not move it anywhere else. I could do it but I would be wearing an orange jumpsuit with some numbers written across the back. People sometimes don't have an understanding of what our budget is."

A second factor that was cited by the district personnel for moving towards the one-to-one program was the desire to replace outdated textbooks with updated digital content. The superintendent explained that with the abundance of digital resources available, teachers should not be relying heavily on old textbooks to deliver instruction: "And we have textbooks that haven't been updated in seven, eight, nine years in some cases."

Shifting the teaching paradigm from a teacher-centered to a more student-centered environment was mentioned by District Three personnel as a third factor contributing to the implementation of a one-to-one initiative. The personnel we spoke to felt the program would promote more student-centered instruction. According to the superintendent, the change will only occur when teachers are giving up their "power in the classroom" and shifting some of the control to the students. She continued, "And I think that may be an issue for many folks.. We're changing from the cemetery rows and the talking head in the front of the classroom" to support student self learning with teachers in a new role as facilitators of learning.

The fourth factor driving the implementation of the one-to-one initiative cited by district personnel was a desire to provide the necessary resources to prepare students for the future. The superintendent explained that they are trying to prepare students for a future workplace that is not known at this point. Furthermore, the superintendent stated it was the school system's responsibility to do this for the students: "We don't know where this digital piece will take our students. We have a moral imperative as educators to prepare our students for their future—not necessarily ours."

4.4.2 Recipes for Success

4.4.2.1 Support of community

The importance of obtaining support from the community was clearly expressed by several participants during District Three's focus group interview. The district leadership team explained there was little time between developing the plan of taking the district towards the one-to-one initiative to actually implementing the program, so there was not much time to build community support for a one-to-one program. The superintendent did, however, speak to the community about one-to-one computing at engagements focused on other district issues.

During the planning stages of the program, the district faced a contentious budget challenge with a reduction in federal, state, and local dollars in the district's annual operating budget. The convergence of a tighter operating budget with the implementation of the new one-to-one technology initiative increased the challenge of obtaining community stakeholders support for the purchase of the iPads. This made the one-to-one initiative a hard sell and political challenge for the district's administration. According to the superintendent during our interview, there were some complaints about using the funds budgeted for new textbooks to purchase the iPads and about the usefulness of the devices for students. In the spring of 2013, several months into the implementation, many of these complaints were dispelled when the district analyzed the results from a comprehensive survey they had sent to parents, students, and teachers. The district's administration pointed to using survey data to dispel criticism in the community. While they had heard complaints and assumed the public was not supportive of the one-to-one program, the data was copacetic. According to the assistant superintendent we interviewed, these results were significant: "I think a major milestone came for us last spring when we did a very comprehensive survey. We had been hearing for a whole year teacher, parent, and student complaints, that 'We don't need [the iPads].' And then we did this very comprehensive survey and the data came back far different." The survey was voluntary and conducted online with parents, students, and teachers involved in the one-to-one initiative. The response rates were as follows: students 44%, teachers 33%, and parents 8%. The students reported that they were using the device almost 60% of the time. In terms of student engagement, 59% of the students felt it increased due to the iPads while 72% of the teachers reported similar feelings.

4.4.2.2 Instructional and technical support

During our focus group, District Three's director of secondary education placed great emphasis on how the success of their one-to-one initiative was a direct result of the leadership displayed by the building level administrators and the instructional and technical support provided by the technology coaches. Instructional support came in the form of trainings provided by the technology coaches. The technology coaches also identified and loaded content specific apps to the iPads for teachers to use with students. During initial deployment at the high schools, technology coaches from the elementary and middle schools came to assist with the process. Other forms of support came from Apple who provided professional training and apps for the iPads valued at $100,000.

4.4.2.3 Responsible use and insurance

Following the advice gleaned from visits to other districts with established one-to-one programs, District Three administrators updated their acceptable use policy and made available an insurance plan that could be purchased by the parents to cover the cost of the iPad's loss or damage not covered by the warranty. In order for students to receive the iPads, District Three personnel required the parents and students to attend a training session to learn about digital citizenship. The district also distributed an acceptable use policy and acceptable computer use agreement detailing the restrictions and expecta-

tions the district had for students using the devices. The parents and students were required to review this policy and sign the agreement forms prior to receiving an iPad. The acceptable use policy contained eight key procedures to be followed which applied to all computer devices, network connections, and software used by employees and students. The eight key procedures centered around:

- prohibiting illegal downloading,
- requiring internet filtering,
- establishing continuous protection whenever students were using the devices,
- establishing monitoring of online activities,
- educating students about social networking, chat rooms and cyberbullying,
- preventing unlawful online activities,
- protecting personal information, and
- educating students about Internet safety.

All students receiving iPads were assigned a *Google* email account. The parents were required to sign an acknowledgment and consent agreement to give the district permission to create the accounts. Students and parents also had to sign a memorandum of understanding that detailed their responsibilities of use and care of the iPads. Finally, parents had to sign an acknowledgment form that allowed their child to opt in or out of the one-to-one initiative. This acknowledgment form also contained the voluntary insurance option for the device. The plan covered the full cost of the iPad except for cases involving intentional abuse. The cost of the insurance was $50.

4.4.2.4 Professional development

District Three's staff took advantage of training provided by Apple. However, they relied more heavily on individualized training created and provided by their technology coaches. The technology coaches created how-to training videos on various apps and also created the digital citizenship training video that all students and parents had to complete prior to receiving the iPads. The Director of Instructional Technology spoke of the usefulness of these trainings: "We found it to be a lot more user friendly and meaningful for our teachers to have the materials and trainings and experiences from our [technology coaches], working with them one on one." The technology coaches we interviewed stated they took some time to assess the teachers and obtain a baseline of their technical know-how and skills and then they built the trainings to be more individualized based on the feedback they received from the teachers. As one technology coach stated, "We realized that a lot of them just weren't comfortable with the mechanics of the device at all. So we started a lot with that. 'Do you have an Apple ID?' And we were surprised that a lot of our teachers didn't. They never had an iTunes account. They've never downloaded a song. So we really had to take a step back and think about that before we could even go into instructional things."

Technology coaches offered training for teachers during their planning periods and after school. Teachers were offered credit for state licensure re-certification as an incentive for attending these training sessions. Teachers could choose training sessions in two durations. The 60 minute sessions were called "meals" and the 15 minute sessions were referred to as "snacks." According to one technology coach, the teachers preferred the shorter sessions because they did not take up their entire planning period. One technology coach explained how doing professional development in this fashion was a better way to get teachers to want to use the device more often in their instruction: "You know we're going to get them in here, tease them, whet their appetite. They're going to come back and want some more. They will end up coming for the "meal" later on, or they are going to be calling us and asking for a one on one." Ac-

cording to one of the technology coaches in our focus group, after the training there was an effort to make sure the teachers were actually incorporating what they learned into their instruction. Technology coaches offered follow-up meetings to plan and teach the lessons with the teachers in the classroom. District Three personnel felt these trainings increased the confidence of the teachers. In the summer preceding the second year of implementation, the technology coaches received a demand by teachers to get the devices back in the hands of the students as soon as possible because the teachers felt the iPads were now indispensable to their teaching.

4.4.2.5 Shared leadership

The district's administration emphasized the importance of receiving feedback from the technology coaches in terms of how and what training sessions to offer to the staff. During the initial planning and implementation stages, the director of secondary education said he developed the plan for what trainings should be provided to teachers. However, he later realized it was a mistake to make all the decisions unilaterally: "What's humbling, I think [is that] we all know that we didn't do everything right. And there were times where our [technology coaches] made recommendations. I may have wanted to do it a certain [different] way." He admitted to us that it was important to listen to the technology coaches when making decisions, as they are closer to the students and teachers. In the second year of the program, he no longer tried to manage the program without their direct input.

District Three's central office personnel believed they provided clear expectations for embedding technology into instruction. The building level administrators were entrusted with the task of monitoring these expectations. As one director explained, "Our principals also have worked with their [teachers] to make sure teachers know this is what we would like to see in the classroom." They made sure that these expectations were supported with professional development provided by the district's technology coaches.

The district's leadership team also left issues related to discipline in the hands of the building level administrators. The director of instructional technology shared with us that it was better to allow the principals "to interpret policies from the student code of conduct" when dealing with issues arising from the misuse of the devices by students. One of the principals described in our focus group a situation in which he caught an exceptional education student playing games on the iPad. He decided to take the device away from the student for a few weeks. He felt this was an appropriate consequence based on the student's needs.

4.4.3 Continually Assessing Needs

District Three has developed a six-year technology plan that spans from 2011 through 2017. This plan includes a goal with several strategies for assessing the needs of teachers as they integrate technology into their curriculum. One strategy involves utilizing the technology coaches as the primary providers of professional development for teachers. The coaches are expected to seek feedback from teachers in regards to the effectiveness of any training offered. A second strategy for achieving this goal is to have "Tech Days" to help teachers become familiar with some of the technologies available to them for instruction. After these events, feedback from teachers must also be collected to determine if the events met their needs. A third strategy is for the district personnel to develop an assessment for determining a teacher's technology competency. The data from this assessment will be used to design additional professional development programs.

4.4.4 Challenges

The district personnel provided several examples of challenges they faced during the planning and implementation stages of

the one-to-one initiative.

4.4.4.1 Funding

One of the biggest challenges involved securing funding for the program. While funding the purchase of iPads with textbook funds was cited as a successful means to begin the project, the superintendent felt that additional funding could have strengthened the program. For instance, in terms of a loaner program for accidental damage, there were no extra iPads available due to the district's limited funding. The superintendent told us that students with broken iPads would have to wait until the device was fixed or until a replacement arrived. To illustrate a practice defined by the district's limited funding, the superintendent said, "We are not immediately giving them a new one. We'd like to go through the process of fixing or having to order the new one with that iPad that they are linked to as opposed to, 'Here is another one and we'll see if we get that one back.' We do not have, let me emphasize this, as a district we do not have a funding source."

The district administration is also looking for additional funding sources in its expansion of ubiquitous computing. During our focus group discussion, the superintendent described the district's application for a new grant provided by their state's department of education for $55,000 per year for four years to purchase additional iPads to support ninth grade math instruction. The administrators we spoke to also discussed ways to maximize their previous investment. They mentioned that the initial iPads would be redistributed to the middle schools in one year when the new iPads are deployed at their high schools.

4.4.4.2 Buy-in

A second challenge was trying to create buy-in within the community for the one-to-one initiative. The superintendent explained how community buy-in was hampered by people's misconceptions about the usefulness of the iPads to students. She said students were using iPads more than the students themselves realized. Addressing her colleagues in our panel, she said,

As you all may [have] recalled, we had a community meeting last year. And one of the comments was from a student in the audience who said, "You can take this iPad, and have it back!" I made a beeline right over to her ...and my intent was to pick up that iPad from her. As I proceeded to do that, she asked me questions, "What am I going to do about my band classes? What am I going to do to study and prepare for my end of the course tests because all of my notes are on it?"

Upon further questioning of the student, the superintendent helped her realize the value the iPad had in her academic life. Part of the solution, the superintendent shared, was getting students, in addition to parents, to see how the new devices were changing the face of learning.

4.4.4.3 Shift teaching paradigm

A third challenge as explained by district staff was trying to get the teachers to use the new technology to change to a more facilitative type classroom environment. The superintendent shared: "sometimes teachers depend on the textbooks" despite having technology readily available. She explained that the district was still working to overcome this challenge, but there is evidence from the one-to-one implementation that they are moving in the right direction. For instance, one of the principals interviewed provided an example of student leadership:

[Teachers] don't feel like they have to know it all to do it all. I heard several teachers tell me this year, 'Oh I got stuck on something in class and a student came forward and helped me out.' I love that. Because they are not worried about trying the apps. They know that many times the students can step in and show them and lead the way.

4.4.4.4 Misuse of iPads

One of the technology coaches during our focus group identified a fourth challenge: students downloading inappropriate content onto the iPads. She said the district had to disable an instant messaging app during the first year of implementation. However, after migrating to a mobile device management tool called Casper, the technicians were able to determine what apps were being downloaded by students and who was trying to bypass the district's firewalls. Even though this was a challenge, the technology coaches we spoke to also emphasized they learned a great deal from students who violated the policies. In some cases, the technology coaches partnered with students to increase the effectiveness of the district's Internet filters. They questioned students on how they were gaining access to sites that were blocked by the filters. As one technology coach explained: "We learned a ton from them. We took for granted that if you couldn't get to Facebook, it's blocked. Then, I'm walking around like, 'How did you get there?' Before I started fussing, I wanted to know how [the student got] that kind of thing."

4.4.5 District Three's Implementation Compared to the Literature

During the interview, the superintendent of District Three discussed placing an emphasis on making the learning environment more facilitative and personalized, one where teachers are not considered the main fount of content within the classroom. The superintendent's belief is echoed in the literature. Researchers point to the desire of one-to-one school districts to change the classroom environment where students receive more personalized instruction through the use of technology (Harris, 2010; Short, 2011). Harvard professor Chris Dede describes teachers as shifting from an "explainer-in-chief to an orchestrator of learning" (Fairbanks, 2013, p .S7) in the context of ubiquitous computing program.

An increase in student engagement has also been cited as one result of implementing one-to-one programs by several researchers (Bebell, 2005; Rockman, 1998; Rutledge, Duran, & Carroll-Miranda, 2007; Short, 2011; Silvernail & Lane, 2004). District Three personnel stated they saw an increase in student engagement as more students were utilizing the iPads and becoming more attached to the devices within the second year of implementation. One technology coach stated, "I had a kid, we just did an interview a couple of weeks ago with a group of kids and the girl said, 'This year I'm really using it for all of my classes.'"

Districts cited in the literature have instituted one-to-one programs as a means to narrow the digital divide (Zardoya & Fico, 2001). This was also a goal expressed clearly by District Three's superintendent during the interview. She talked about this technology creating a sense of equity among the students. It was also decided by the district leadership team to start closing the digital gap with the high school students first, since they had more pressures with on-time graduation and computerized state mandated assessments.

In the research about professional development for teachers in districts incorporating one-to-one initiatives, several researchers reported the importance of allowing the teachers time to become comfortable with the new technology before offering training to change pedagogy (Dalgarno, 2009; Donovan et al., 2007; Murphy et al., 2007; Potter & Rockinson-Szapkiw, 2012). The technology coaches in District Three followed this recommendation as they developed training for the teachers. A principal we interviewed mentioned the technology coaches offered professional development that was differentiated based on the teacher's current skill set. He described for us two generalized groups of teachers: "[those] that didn't know how to turn the device on" and "those who were ready to implement very creative uses in their classes." One technology coach spoke about how it was important to get a sense of where each teacher was

in terms of his or her comfort level with the technology. The personnel in District Three saw this as a major milestone in their implementation of the one-to-one because this differentiation in training kept teachers from feeling overwhelmed and made them more willing to accept changing their pedagogical approach to teaching using technology.

A prevalent recommendation found in the literature of successful one-to-one programs indicates that professional development continue throughout the implementation (Blumenfeld et al., 1991; Burns, 2002; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Wang, 2000). District Three's personnel provided evidence of continued professional development as they described the various training opportunities they offered to teachers. District personnel cited the training sessions as being successful.

District Three's program had several similarities when compared to the findings of current research on one-to-one initiatives. There was a focus to make the learning more student centered, more personalized, and more engaging. The district's personnel had a vision to close the digital divide among students by providing additional access to technology. Finally, the district personnel saw the importance of offering differentiated professional development to help change teacher pedagogy as cited in the research (Donovan et al., 2007).

4.5 District Four Profile

District Four is located in a rural county with a population of over 21,000. The median household income is $82,683. More than 2,400 students in pre-kindergarten through twelfth grades attend three elementary schools, one middle school, one high school, and an alternative center. District Four's mission emphasizes preparing students to have a positive influence in the world; the district's vision emphasizes a personalized approach to meet the needs of all learners.

Since 1997, District Four has sourced its technology for students exclusively from Apple. In addition to iPads, the district supplies iMac desktop computers, MacBook laptops, and iPod Touch mobile devices. Each teacher has been issued a MacBook laptop since 2001. The district's goal, according to the assistant superintendent of instruction, has always been "to ensure teachers and students have the tools and training to integrate technology into their teaching and learning experiences."

In late 2012, a new superintendent was hired. His prior district had implemented a one-to-one program and he wanted District Four to provide a device for every student. In our discussion with the superintendent, he told us he proposed a question to the district technology team: "If I said that you had the money, how could you make it happen in six months and how would you do it?" Using textbook funds, the district was able to purchase enough iPad Minis to run the program as a pilot in one of the district's elementary schools. The iPad Minis were chosen due to the district's previous investment in Apple, as well as the portability, long battery life, and access to a mobile device management system. Also, one participant interviewed indicated that he believed that among the tablet options available, that the apps on the iPad Minis were most appropriate for educating students.

4.5.1 One-to-One Implementation

District Four began the iPad Mini initiative in the fall of 2013. Central office staff was strategic in choosing the location of the pilot elementary school. District staff we interviewed cited three reasons for choosing their pilot school. Participants mentioned an economic equity division among the county's east and west ends. The superintendent explained this perception of inequity had to be taken into consideration when selecting the pilot school: "We chose central specifically, so it didn't look like we were picking favorites." The presence of a supportive princi-

pal and teaching staff of the innovation that new technology may bring to their school was a second reason for choosing the pilot school. Finally, the centrally located elementary school was also close to the district's technology building and the staff there could provide support.

In preparing for the one-to-one pilot, the district's technology team also had to reconsider the demands additional devices would have on infrastructure. Although District Four had been supporting wireless technology in the district since 1999, the wireless network needed to be revisited to support 160 iPad Minis in one building. The district's technical coordinator spoke of "beefing up" the infrastructure by increasing the number of wireless access points in the pilot school by 20%. He also shared with us that he hoped to increase the bandwidth even further in the future, beyond the 100MBit connection the district currently uses. The rural portions of the county cannot support connectivity beyond this point due to a lack of Internet providers expanding their service to these areas.

District Four began training staff in the summer of 2013. All third, fourth, and fifth grade teachers, the school media specialist, and principal at the pilot school attended a three-day summer training. According to the principal, the teachers all received iPad Minis and interactive whiteboard software on their computer, if they did not have them already. The instructional technology supervisor led the sessions focused on how technology changes instruction. Near the end of the summer, a technology coach was hired to mainly spend time supporting staff at the pilot school. As a part of continued professional development, the third through fifth grade teachers were given a substitute for a half-day to be trained with the technology coach in the fall. The principal hopes to continue the half-day training between the technology coach and teachers once every nine weeks as long as the substitute funds are available. The technology coach spoke of ongoing support she provides through emails: "A lot of times, if they have a question and I'm not there because I'm working in three different elementary schools, they will email me. And even if we're at home for the evening, then, I'll just do a quick video tutorial and send it to them. So, they have access to somebody that will be there to support them at all times."

The iPad Minis were given to third, fourth, and fifth grade students. The students' parents attended a mandatory parent meeting to hear about digital citizenship, 21st century skills, changes in learning pedagogy, and were able to ask questions regarding the initiative. Parents signed the permission form and acceptable use policy (AUP) before students were allowed to take the iPad Minis home. Staff chose to stagger the rollout and held meetings for parents of fifth graders in August, fourth graders in September and third graders in October.

4.5.2 Recipes for Success

4.5.2.1 Initial support

According to the director of technology, two staff members planned the three day summer training focused on basic usage, apps, and changes in teacher pedagogy. The teachers received the iPad Minis at the training. The superintendent understood the need of human support and chose to create a technology coach position over filling a central office position that had been vacated by attrition. He stated, "I have always been a believer that the closer you can put leadership to the classroom, the more likely you are going to see success." This new technology coach was assigned to the pilot school three days a week and continues to provide support for teachers during and after school hours.

4.5.2.2 Support of community

From the initial planning stages, the community has been well informed of the rollout process. In April of 2013, the school board approved a technology plan that outlined the pilot school and the subsequent rollout of the one-to-one initiative

in all elementary and middle schools within five years. The pilot school has a devoted webpage with information about the one-to-one program, frequently asked question for parents, forms related to the one-to-one, and a video of the superintendent, principal and the supervisor of instructional technology discussing the pilot program. The district staff we interviewed reported parents have shown enthusiasm regarding their child using the iPad Mini as a part of their instruction. About one parent per grade level held one on one discussions with the principal regarding their concerns over students having access to email and the security of the device, but after the discussions, every parent did sign permission for their child to use the iPad.

4.5.2.3 Responsible use and insurance

Parents paid a $35 insurance fee for the iPad Mini the pilot year. District Four collected the fee during each parent night. The pilot school has 20% of its students qualifying for free and reduced lunch but every parent paid the full fee amount with no support from the school or the parent teacher association.

All students and parents also signed the AUP and permission form. The AUP was modified slightly this year to reflect the implementation of the one-to-one initiative. The responsibilities of use and digital citizenship are taught by classroom teachers. The teachers and the technology coach collaborated to create six specific guidelines for student use of the iPad Minis, called "iPad Smarts." These "smarts" remind students to search safely, create their own work, charge and take care of the iPad, respect others with the device, ask a teacher if they feel uncomfortable or have a problem, and stay on track with the class.

4.5.2.4 Continued professional development

After the initial support teachers and administrator received from the three-day summer training and the hiring of a technology coach, the teachers were given personalized training by the technology coach in the fall. Substitutes were provided, which allowed teachers to receive four hours of uninterrupted training during contractual time. The technology coach also answers about 60 emails or iChats (instant messaging) a week from teachers.

4.5.2.5 Administrative support

The principal showed administrative support through her attendance of several different events. The principal, along with other central office staff, attended a "briefing" held by Apple during the summer before deployment. The briefing was a sales presentation regarding the use of iPads in education. The principal also attended the International Society for Technology Education (ISTE) Conference, where she participated in sessions related to ubiquitous computing. The principal also attended all three days of the district's summer training alongside the teachers. During our interview, the principal spoke of encouraging her teachers to continue working through technical difficulties without fear of an evaluation. "Some things just didn't work out as the teachers hoped. I joked with a teacher, one of the fifth grade teachers. So, I said that everything you have tried so far has failed. [The teacher said,] "Yes, but I still have a positive attitude." Because they know this is a pilot, things are going to go wrong. That will never be held against you. It is not punitive. You know, just keep trying."

4.5.2.6 Continual assessment of needs

Student engagement was spoken of in interviews as an informal measure of the iPad initiative. All of the interview participants observed an increase in enthusiasm and involvement of students in their studies due to the use of iPads. The principal spoke of an interaction between an assistant superintendent and a student. "One student was working on something and [the assistant superintendent] happened to be in the room, and he said, "Are you having fun doing this?" [The student] said, "We always have fun at school." What better praise can you get than fifth grader saying we always have fun at school? That was

a huge compliment to me."

A letter to parents was sent home in January of the pilot year to request stakeholder perceptions and needs of the initiative. A nine-question survey was included with the letter, and it was also available via a link to be completed online. Fifteen responses came back with both positive feedback and concerns. Some parents felt they needed more time to understand the functionality of the iPad Minis. Overall, parents felt the size of the iPad Minis were a good fit and that their child had a positive experience in and out of school with the device. One parent commented, "The iPad Mini has inspired a true learning experience for my child." District Four staff are planning to address concerns individually. District Four personnel are also developing a more comprehensive survey to be sent home at the end of the year.

4.5.3 Challenges

The participants described several challenges in the first year of the pilot. The first challenge was meeting the demands of deployment with limited human capital. The technology department staff, along with the principal and the librarian of the pilot school each contributed to the iPad Mini deployment. Two technology coaches manually placed a cover on each of the 160 iPad Minis and downloaded apps. The principal and the district's instructional technology supervisor were also responsible for planning all three of the parent nights.

Another challenge expressed by many interviewed was regarding the small number of technical staff available to provide support for the teachers and students. When a system update became available to download on the iPad Minis, students saw the download button and proceeded to update. This update rendered the management system used by the district's coordinator of technology to become inoperable. While this particular challenge was corrected by one person, any future challenges like this one, requiring individual configuration on each device, would not scale with the district's current staffing.

A technical challenge expressed was the lack of data storage for the iPad Minis. Although several apps allow for "cloud storage," if a device fails, there is no method of retrieving all of the information from the apps at this point. Also, if a student leaves the device at home, there is no backup of the program for the students to access from school. At this point, the pilot school guideline is to allow students to call their parents to bring the device to school up to three times if they leave it at home. A student may also have his or her permission to take the device home revoked if bringing it back is a challenge. The principal stated that one student had to leave the iPad Mini at school for several weeks before being allowed to take it home again due to his inability to remember to bring it to school daily.

Another challenge brought up by the technology coach in the interview spoke to a lack of planning time for the teachers. Overall, she felt the teachers were excited about the use of technology in their classrooms. However, they have expressed to the technology coach their need for additional time during the day for training or planning for using the iPads in lessons.

The community has been supportive overall of the initiative. However, some concerns have been expressed by the community. In January of the pilot year, one parent during the public comment period of a school board meeting brought up questions of the benefits of the iPad Minis compared to the funding spent. The parent questioned how teachers were using the iPad Minis as a means of changing teacher pedagogy. Within the meeting, board members reviewing the upcoming budget proposal also asked about benefits versus cost. The superintendent responded to the parent and the board that because of the infancy of the initiative, effectiveness of the devices is still being assessed and is not conclusive. However, the superintendent cited positive changes he witnessed in classrooms as favorable informal assessments.

A final challenge expressed by some leaders in the district relate to the community's ability to access Internet at home. According to the technical coordinator, Internet companies do not provide access to the rural areas of the community. He stated, "We don't have enough people per street mile to bring in the Comcasts and Verizons of the world… they're looking for a return on their investment." The superintendent also expressed concerns: "Even though we are already seeing innovative instruction in the classroom, we still do not have capacity at home to engage in "anytime" learning with all students. This technology gap, not just for low-income families, but even affluent rural families, is a major concern for us if we are to be able to maximize the implementation of the initiative." According to the superintendent, the Board of Supervisors for the district created a High Speed Internet Committee in April of 2013. In October, 2013 the committee released a report that outlined seven recommendations that may entice Internet companies to deliver more services across the county. At this time, no major changes have been made as a result of the report and the lack of Internet services for all students continue to be a concern for district leaders.

4.5.4 District Four's Implementation Compared to the Literature

The literature suggests that teachers receive their devices from six to twelve months ahead of the students. District Four's technology team handed iPad Minis out two and a half months before the students received them. However, teachers in the district had experience with iOS devices including iPads and iPod Touch devices at least two years prior to the one-to-one. The District encouraged use of these devices with classroom carts and even had a checkout system for teachers to take them home on weekends. Although the actual time frame was short for deployment, the previous experiences the teachers had with devices before the one-to-one was helpful for teachers to feel more comfortable with using the devices with students in a one-to-one setting.

Professional development is also crucial, as pointed out in the literature. District Four chose to train the teachers with in-house staff as opposed to Apple trainers. Although Apple provided technical support, the in-house staff was able to provide the technical and pedagogical training that gave teachers the foundation to use the iPad Minis instructionally in the classroom. The continual support provided by the technology coach at the pilot school also aligns with what literature states is an important element to sustain a mobile initiative.

District Four, in their first year of a pilot program with ubiquitous computing, has had challenges that were similar to other districts deploying one device to each student. The vision of the district leadership team of realizing the potential of every learner through personalized learning has been the inspiration behind the purposeful planning of the initiative. The interview participants see the overall positive outcomes of student engagement and teacher enthusiasm as being good indicators of success and hope to see this trend continue as the year progresses.

4.6 District Five Profile

District Five is located in the midwest region of the United States and has a population of over 110,000. There are two higher education institutions that serve the area. Thirty-one percent of the households in the area have school-aged children. The median income for families in the district is $40,000 a year. The district is made up of twelve elementary, three middle, two high, one middle/high and two alternative schools. The district serves a student population of approximately 10,500. The district has a freshman graduation rate of 88.3% and a dropout rate of 3% for ninth through twelfth grades. According to statistics published on the District Five's website, their per pupil

expenditure is $9,450 per year.

The district's leadership espouses the desire "to become nationally recognized as a premier provider of education by serving as the bridge connecting stakeholders to ensure all students are college and career ready," as articulated through their vision statement. The district's mission "is for stakeholders to give 100 percent effort in meeting the academic and behavioral needs of each student ensuring acceptance to post-secondary opportunity." By August 2014, the district's strategic plan calls for equitable access to technology that will be available to 100 percent of faculty, staff, students, and parents so that education is enhanced and learning is facilitated. District Five's leadership has attempted to reach this goal for equitable access through the implementation of a one-to-one program. Included in their plans are steps to maintain sustainability for their program, which began in 2013 and serves third through twelve graders.

4.6.1 One-to-One Computing

District Five is similar to other districts across the county in their use of technology. Students initially had access to technology through traditional computer labs. There were approximately 50 labs across the district, a handful of carts with either laptops or mini-laptops and about 50% of the classrooms were equipped with interactive whiteboards. Prior to the one-to-one implementation, teachers used these interactive whiteboards primarily through teacher directed instruction, with limited student use of the interactive technology. As stated by the director of technology during our interview, the number of classrooms equipped with interactive whiteboards rose to 80% after the implementation of one-to-one initiative.

As they prepared to initiate their ubiquitous district-wide program, District Five's technology team conducted their own internal research. Prior to one-to-one implementation, a 3-year pilot was conducted at the middle and high school levels which utilized MacBook Pro laptops. This was the district's first experience with a one-to-one program. Subsequent to the pilot, the district conducted an additional pilot with a variety of platforms. This pilot included three different devices: the Apple iPad, the Samsung Chromebook, and the Microsoft Surface. Each school had a technology contact person that organized a focus group of individuals to evaluate each of the three devices. The focus groups consisted of students and teachers. For approximately six weeks, the participants tested out the devices. After the pilot period, the technology contacts from all of the schools met for a full day to assess the utility of each device. The team then met again a month later to review final recommendations for which device they were going to select for deployment. One of the interview participants stated: "We decided to put together a plan for Chromebooks for grades three through twelve. And then in April of last year, we got approval for a 3-year lease for 8,000 devices by our school board." In addition to handing out 8,000 student devices, 700 certified staff members received the same device.

To support the change to one-to-one, the school board approved funding to hire technology coaches. The director of technology shared that hiring the three technology coaches was critical to the successful implementation of the technology initiative. To further undergird the initial rollout of the devices, the technology director indicated that the district technology team hosted an e-Learning conference. "We were awarded a grant by our state and the e-Learning conference that we hosted in July was also going to be a big part of our kick-off for our initiative. [Our goal was] to bring our teachers up to speed on the device and help to inspire them on how they could use the device with students in their classrooms."

4.6.2 Recipe for Success

4.6.2.1 Support of the community

Videos were developed that illustrated the process for teacher and student rollout. This video was embedded into the district's

website to serve as a public relations tool and to showcase the district's new initiative. The video includes a voiceover that narrates a report developed by the district to articulate the vision of the one-to-one initiative. The video was also distributed via social media.

4.6.2.2 Instructional and technical support

The technology coach is a new position for the district that was developed to support the one-to-one initiative. The technology director indicated in our interview that the district designed and created the position to meet the instructional technology needs of the one-to-one. There are three technology coaches who are each responsible for six to seven of the districts' 19 school buildings. Each of the technology coaches are responsible for working with all grade levels, although two are primarily assigned to the largest high schools. These positions are split throughout the district mainly by geographic area.

To foster and initiate a change in pedagogy the technology coaches were included in the implementation process. The role of these technology coaches was to assist in the process of classrooms becoming more student centered. During the first year of implementation, the technology coaches observed teachers progressing along a continuum of technology use. District Five has used the SAMR model, which articulates how technology use is applied to teaching and learning (Puentedura, 2013). Early on, teachers were substituting traditional instructional resources with newer digital ones. Technology coaches have helped teachers to move beyond this stage, using technology to augment pedagogy in new ways. Among the instructional aims with new technology, teachers in the district are being guided towards inquiry-based learning and enhanced communication between students and teachers. One specific manifestation of this new paradigm used by some teachers in the district is "flipping the classroom"—a pedagogy that frees classroom time for discussion by asking students to engage with new material at home. A desire to have the teacher provide more integration in the classroom with technology as a tool was expressed by administrators and technology coaches that participated in the focus group. One of the technology coaches expressed that due to the newness of the initiative the district is "just scratching the surface of how it is going to change classroom instruction." In addition to technology coaches assisting with changing pedagogy they are also encouraging teachers to integrate technology more.

4.6.2.3 Responsible use and insurance

A review of District Five's documents demonstrate the district's positive focus on technology use as opposed to a negative list of restrictions. For example, the *Computer Device Policy*, Section 7.4 reads as follows: "Students are permitted to bring their devices with them to extra-curricular activities." Though there are still prohibitions in the policy, the technology director emphasized that it was important to direct students to the learning focus associated with the devices. He spoke of revising the acceptable use policy to reflect a positive focus and that it will be reviewed and revised as needed. During the focus group session there was discussion regarding how the district embeds the insurance cost within the lease fee. The director of technology said: "We actually are charging our families less than $20 in the first year of the [deployment of the] device. Again, one of our long-term goals is to move away from textbooks and [...] reduce textbook fees." He continued with the following regarding fees:

Our very first year, [the student's] technology fee only went up by $11. That covered the cost of the device and also covered accidental damage, unlimited claims, and no deductible for our parents. The only thing that our insurance didn't cover was theft and vandalism. Our insurance company offered $12 a year. A parent could buy theft and vandalism insurance through our insurance company. Or they could go through their own insurance company that

they use for homeowners or renters insurance and get theft and vandalism through them as well.

The staff of District Five say they are committed to making sure their students are responsible users of technology. At the point of our interview with District Five personnel, they had just formed a digital citizenship academy committee. The committee is developing a curriculum for teaching students principles of digital citizenship with the hope that it will be used with all students at the start of the next school year. The district team in our focus group plans to promote good digital citizenship as a healthy, constructive way to deal with those discipline issues that they may face as part of the implementation.

4.6.2.4 Professional development

The district technology team conducted a teacher rollout day which the technology director described as "very basic PD." Furthermore, the focus group participants, indicated that a July, 2013, conference was held for teachers and there were plans to host a second conference for teachers in July, 2014.

District Five staff described an ongoing model of training that takes place during a planning block during the school day called "period zero." Training takes place before the instructional school day and can occur up to three times a week depending on the preference of the school principal. The principal that we spoke with described her use of the period zero in this way: "We run a monthly [training] with our [technology] coach. We have a date set up every month that she comes to give overall PD… we would differentiate our PD because we have various levels [of teacher needs]." Coupled with the period zero training, instructional technology staff members interviewed described their continual presence in classrooms to assist teachers daily. The technology director clarified the role of his coaches: "[The technology coaches] are in classrooms. They are co-teaching. They are meeting with teachers during their planning periods. We have professional development centered around our one-to-one initiative going on all year long and on a daily basis in all our buildings".

Personnel we interviewed also cited that teachers are rising to the challenge by becoming technology teacher leaders. At the time of our interview, the technology team in District Five was launching a three-week e-Learning Challenge to highlight technology tools. They planned to publish a new blog post written by technology coaches over 15 consecutive school days. The purpose of the blog posts was to encourage the exploration of different websites or different teaching styles for use in teachers' classrooms. The teachers were encouraged to respond through comments to the blogs by adding their experiences and examples of use of the tools featured in the daily blog post. The e-Learning Challenge is an example of the collaboration and development of leadership the technology director is trying to instill among teachers, media specialists, and technology contacts.

4.6.2.5 Administrator support

One year prior to the one-to-one implementation, all administrators received two days of training: one in the fall and one in the spring. The training focused on technology integration. The principal in the group acknowledged the difficulty some teachers may experience with the change brought on by technology integration. She emphasized that administrators have to help teachers see that the change is necessary and good. The principal also stated that this change is what is best for students. She recognized the importance of gathering teacher input to assess their needs and then to adjust the digital learning training sessions to meet these needs.

4.5.2.6 Continually assessing needs

The district leaders developed a rubric that will be used to assess how far teachers have progressed with meeting the goals of

the district. Determining the level of technology integration in classrooms is one of the components of the rubric. According to the technology director, the rubric will help the district review how their teachers and students are using the Chromebook and if they are utilizing it in a way that promotes lifelong learning. At this time, using the rubric in a formal teacher evaluation is only being discussed. The technology director said, "We have not tried to add any part of technology integration as far as [the teacher's] formal evaluation process. But I think that's the direction we're going to be discussing [here soon] with our principals."

4.6.3 Challenges

The focus group participants identified two challenges they experienced thus far during their one-to-one implementation. The first challenge was dealing with the repairs of broken devices. During the interview, the technology director expressed frustration associated with the length of time it took for broken laptops to be returned. Currently, students are experiencing a three week return time for broken devices. The technology director's expectation is that students should have their repaired devices returned within a week's time. Furthermore, he strongly expressed the need for a loaner computer to be available during the repair period. Based on the data collected during the focus group and a review of information published on the district's website, there was inconsistency regarding the issuance of loaner computers. The director indicated that some schools do a good job with providing loaners while others do not.

Another challenge discussed by the focus group was helping teachers and students understand that the purpose of the one-to-one is to facilitate learning, not primarily to facilitate administration of assessments. Coincidently, implementation of a new policy requiring biweekly testing and the deployment of the devices occurred simultaneously. Therefore the challenge, as stated by the technology director, has been "making sure both teachers and students are using the devices [in ways] that promote and [are] leveraged for learning."

4.6.4 District Five's Implementation Compared to the Literature

District Five staff recognized the need for differentiated professional development. This recognition was present in the literature, as a means to support school staff with varying levels of comfort and knowledge with technology. Likewise, District Five staff embraced the idea of ongoing professional development that utilizes instructional technology staff, teacher leaders and student experts.

In contrast to the literature, the technology director indicated the four to six months time frame for planning was sufficient. He stated that although a year of planning time would have been preferred, it was not necessary. This is in contradiction to the literature that recommends staff members receive the devices a year ahead of the student deployment. The technology director compares starting a one-to-one to getting married: "If you wait until the right time to get married, you'll never get married. So if you wait until the right time [until] everyone is on board [and] wants to use technology before you adopt a one-to-one device, you'll never adopt a one-to-one device." During the focus group sessions, it was expressed by a technology coach that some teachers had a very difficult time integrating technology: "There were a lot of questions, 'In a couple of days, I am going to have 30 kids in my class with this Chromebook, what are we doing with it?' We tried to answer those as best as we could."

The experience shared with us through our focus group interview with staff from District Five is congruent with other cases cited in the literature, as they are currently facing challenges not dissimilar to those documented in other one-to-one deployments.

4.7 Conclusion

In this chapter of our study, we provided the story behind each district's journey towards implementing a ubiquitous computing program. We examined each district's successes, challenges, and experiences and compared them to the literature. Even though each story was unique, we saw some similarities and distinctions in the implementation plans. In the next chapter, we compare all five districts and provide an analysis of the interviews, focus groups, and documents.

Data Analysis

5.1 Introduction

Our multiple case analysis, using data collected from focus group and individual interviews and program-related documents, was done by using a logic model to describe the quintain (see Figure 5-1). Stakeholders in each case district experienced a similar process of starting one-to-one computing. By using a logic model, we took stock of the themes that emerge in our analysis and discussed how these themes were articulated across each case. We chose to highlight both successes and challenges faced by district stakeholders in each stage of the logic model to illustrate possible best practices.

5.2 A Logic Model for One-to-One Deployment

School district leaders will experience similar experiences implementing ubiquitous programs. We developed a logic model

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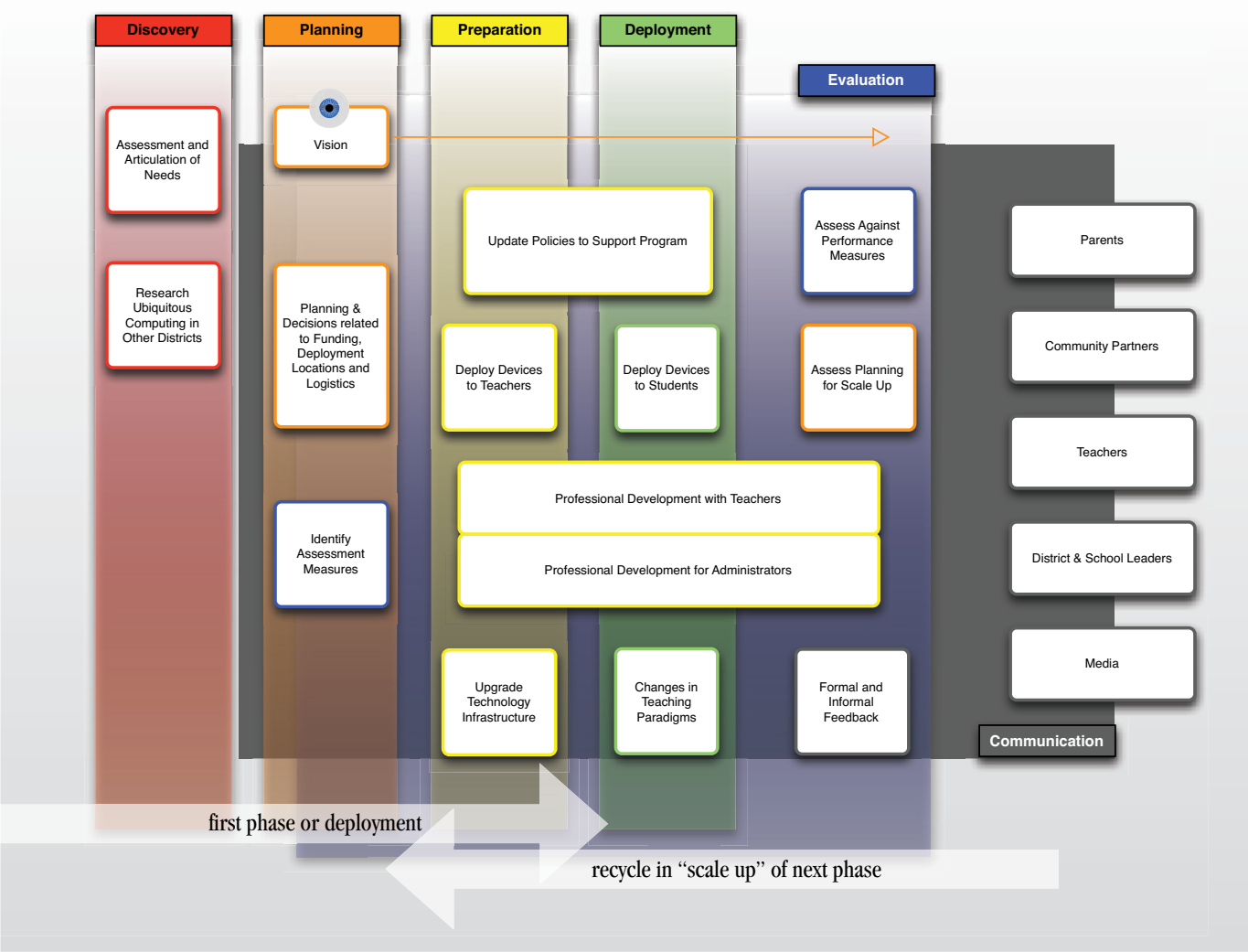


Figure 5-1. Logic model for a one-to-one implementation. The stages of discovery, planning, preparation, deployment, and evaluation may be read from left-to-right, one stage started before the next. Evaluation likely should occur in concert with the planning, preparation, and deployment stages. Communication, likewise, will be ongoing during all the stages except discovery. Within each stage's "band" or "column," we have listed a series of steps to be undertaken within a stage. While these steps may be approached consecutively, they may also be undertaken simultaneously. The communication "steps" are not presented in any particular order, but instead list the various stakeholders to engage with communication.

that describes this process with five components or stages: discovery, planning, preparation, deployment, and evaluation. In addition, the ongoing process of communication plays a role in our model. The model does not precisely describe the process followed by any one specific district's leadership, but instead is a generalization of the process across all cases, including elements of best practice gleaned from the literature.

5.2.1 Discovery

In the first stage of the model, a district's leaders take stock of their current and future needs with instruction. For at least one of the districts we studied, this stage was theoretical, while for others, it was more formal. Districts we studied articulated various reasons for their programs, including increasing equity and access to information, increasing student engagement, and changing classroom paradigms. Only when district leaders decide that a ubiquitous computing program is a viable solution to their needs does the model progress to the second stage.

5.2.2 Planning

In this stage, district leaders acknowledge that a ubiquitous program is a potential solution to their needs and they begin to develop a roadmap or guide on how the project will take place. The planning stage will likely continue into subsequent stages, especially in cases where pilot programs are utilized. Planning involves making decisions related to funding the project, developing the metrics on how to evaluate the program, and making logistical decisions about where to start (schools, grade levels, etc.), and which employees will support the program. During this stage, a vision is formed for "why are we doing this" (Apple, 2007). This vision should persist throughout the project.

5.2.3 Preparation

As district leaders move forward with preparing for deployment of devices to staff and students, a revision of technology policies may be warranted. A ubiquitous program will introduce new procedures for loaning equipment and may also involve insurance fees for parents. If technology use in the classroom is considered novel, policies and procedures relating to student discipline may also warrant revision. The next step in the preparation stage includes deploying devices to teachers and other staff. Once the devices are in the hands of the teachers, providing professional development to both teachers and administrators prepares them for deployment to students. In almost all of the cases studied, the professional development at this stage covered operation of the new equipment. A final component of the preparation stage is the possible upgrade of the technology infrastructure to support the increases in bandwidth and wireless capacity required with deployment.

5.2.4 Deployment

Deployment is the stage where computing devices have been put into the hands of students. In their guide to one-to-one deployments, Apple Computer (2007) articulated this stage in two phases, the first focused on getting all the devices in the hands of teachers and students, and the second focused on what to do once everyone gains comfort with the devices. The deployment stage may also include training sessions for students and parents in addition to payment by parents of insurance fees. The critical stages of professional development focused on pedagogy will take place during the deployment stage.

5.2.5 Evaluation

All districts do not implement a formal evaluation component in their program. In some cases, districts utilize outside research firms to conduct pre- and post-assessments of their instructional programs associated with one-to-one computing. Evaluations can encompass multiple facets of the program, including student and parental satisfaction, student outcomes (achievement, attendance, discipline), teacher progress in the evolution of pedagogy, and data associated with device repair

and replacement. Evaluation starts at the planning stage and continues at each subsequent stage of the logic model. Evaluations should be correlated to the goals and vision for the program.

5.2.6 Communication

Communication is a key process that transcends the linear path suggested by the logic model. Communication to parents and the community often occurs in the beginning of the planning stage and continues as long as the program is operational. Communication in the early stages may take the form of community gatherings, board meetings, or any time a member of leadership speaks on issues regarding the school district. One-to-one pioneer Dr. Mark Edwards underscored the importance of communication in developing support for the initiative: "One of the most important lessons I had learned in Henrico County is that internal and external support is essential to success and is always a work in progress" (Edwards, 2014, p. xiv).

After the community is made aware of the vision and goals of the initiative, the district may continue to keep the community informed of the preparation and deployment stages of the program. According to a district leader with experience in one-to-one, communication to parents was just as important as communication to the local media.

Once the vision for a 1 to 1 initiative has been crafted, it will be necessary to start providing information to all the constituents, select someone to act as the PR/communication spokesperson for the 1 to 1 initiative to ensure continuity of the messaging. This person can also help determine the messages to be communicated, the structure and schedule of the messages, and how best to work with media representatives (Apple Computer, 2007, p. 28).

5.3 Discovery Case Comparisons

Within the area of district discovery, seven themes emerged from our source data across all five districts. Several themes are grouped around instruction, in addition to leadership, a district's past history using technology, and research about ubiquitous computing.

5.3.1 Academic Preparation

One instructional theme emerged around academic preparation, specifically testing and textbooks. Leaders from two of the districts identified concerns about testing as a rationale for considering a one-to-one initiative. Students across multiple districts are required to take state tests electronically. Leaders from District Three were specifically concerned that state tests with interactive questions would be given on computers and students would not have had adequate preparation without more access to technology. During our focus group interview with District One staff, they reported significant increases in student writing scores after just a few years into the implementation. Personnel in District Four did not place such a strong focus on testing. Instead they developed their vision with the belief that an increase in student achievement would occur as a direct result of increasing student engagement.

In District Three, the leadership personnel expressed that they wanted to use the technology to replace outdated textbooks, some of which had not been updated in "seven to nine years" with a digitally-based curriculum. They felt that the process to replace textbooks was time consuming, and their students and teachers could gain more benefits from using online resources.

5.3.2 Desire to Change Instructional Practices

The theme of academic preparation continued in discussions about instructional practices. All of the districts we studied expressed an interest through interviews and through their

documentation for changing classroom practice. A desire for improving student engagement with learning was articulated by many of the district leaders we interviewed, including one assistant superintendent of instruction: "[our district is] focused on instructional innovation; we're absolutely focused on engaging all of our students, and we're talking—our conversations are really framed around student engagement in a way that they haven't necessarily been in the past." Beyond student engagement, changes in instruction were articulated in a number of different ways.

Collectively, leaders from Districts Two, Three, and Five were interested in using one-to-one computing to replace the role of textbooks. Leaders from Districts Three and Four also spoke to us about plans to leverage one-to-one devices to support virtual classes. In one instance, the developed classes would be offered to the multiple high schools within the district to expand their catalog of elective courses, such as world languages.

Another commonality was a desire for a change in what teaching and learning looked like from a student's perspective. Offering "real world" opportunities was a goal in one district, while changing the teacher's role to facilitator was articulated as a desire in another. In District Five, where teaching traditionally was described as "guided instruction," leaders echoed the call for teachers as facilitators, calling for "teachers to move away from lecture" and a desire for more evidence of "interactive instruction." The same leaders told us they wanted instruction for students to become more personalized.

District Four leaders, before their one-to-one pilot, already had invested resources in professional development supporting collaborative, project-based learning in their K-12 classrooms. District One leaders implemented a similar program after their one-to-one initiative had been established. The leaders we interviewed in these two districts believed that "going one-to-one" was a natural evolution of their vision for changing instructional practices.

5.3.3 Preparation for the Future

Leaders in District Five expressed that students would be better prepared to be make significant changes in the world if the traditional teaching styles were altered to be more facilitative and student-centered. These district leaders also believed that by introducing a one-to-one program, teaching could continue with students beyond a regular school day. We saw evidence from District Four with leaders' desire to empower students to make a positive impact in the world. These leaders cited their decision to implement their ubiquitous program as a solution to this goal.

In four districts, leaders voiced a concern for developing workplace readiness skills or so-called twenty-first century skills, such as communication, collaboration, creativity, and critical thinking. Personnel interviewed from District One recounted their concern before their one-to-one implementation about adequately preparing soon-to-be graduating high school students for the workforce and higher education. They also expressed concerns about increasing their graduation rates, especially at schools in their lower socio-economic neighborhoods.

Personnel in District Two expressed concerns about adequately preparing students for new jobs in the community requiring high technology skills. A new local college program was already aligned with preparing the workforce for new businesses in the community.

5.3.4 Digital Divide

The theme of using technology to bridge the digital divide and bring equity among students was prevalent in interviews held with participants of Districts One, Three, and Four. In Districts One and Four, the participants spoke of a geographical "line" that was drawn along a socioeconomic divide. Staff at both

districts felt that providing technology to students would help those less fortunate acquire parity in access to Internet-enabled instruction. Leaders from all three districts emphasized that every student within the district deserved to have access to technology for "learning anytime, anywhere." District One even secured a partnership with a local Internet company to ensure lower cost for internet at home for its students.

District One leaders also saw the one-to-one program as providing hope to those disadvantaged students whose first and possibly only experience with a laptop was through the district's initiative. When the District Three superintendent spoke of preparing students for the future with technology, she saw it as more than just an expectation but more of a "moral imperative" for the district to move in that direction.

5.3.5 Leadership

The theme of leadership emerged many times across the districts as the source of a desire to explore and implement a one-to-one program. Specifically, many of the districts cited the superintendent as a catalyst for their programs. In four of the districts, personnel had previous experience with ubiquitous computing. District Two leaders piloted one-to-one computing with handheld devices twelve years previous to their iPad program. Superintendents in Districts Three and Four had previous experience with one-to-one programs before they came to their current districts. In District Five, an outgoing superintendent had conducted a pilot before leaving. We learned that prior experience helped guide those superintendents and leaders in making their newer implementations more efficient.

Through several interviews, we learned about the pre-deployment beliefs of the leaders who led one-to-one programs. These varied among the districts and helped guide the vision forming that would follow. The technology director we interviewed in District Five spoke of their district's plans for creating future community leaders, changing teaching practices, and increasing the potential for student-teacher communications beyond the formal school day. Because of the district's previous attempt at one-to-one computing, both the community and the school board were highly supportive of the new superintendent's solution of one-to-one computing to address their instructional strategies. A former superintendent in District One believed that the district's investment in technology was not helping students who did not have similar access in their homes, citing his development of a "moral imperative" to later develop plans for one-to-one computing. District Three's superintendent told us new technology had to be prioritized for use in the classroom, given the district's previous failure to fully provide requisite access for meaningful technology integration for instruction.

Members of the leadership team in District Four were engaged with exploring the possibilities of a one-to-one program for a long time before the arrival of a new superintendent who gave the idea his approval. They questioned whether or not they had the requisite technical support and expertise to start a one-to-one program in a short period of time. Ultimately, however, District Four's leadership recognized that their agility in being able to implement new programs because of their smaller size, their fearlessness in making mistakes and learning from them, and having enough experienced, interested teachers in participating in a one-to-one program, was enough to make a decision to move forward into the planning stage.

5.3.6 Previous Technology Experience

Prior to the implementation of their one-to-one initiative, classroom instruction was described as being "traditional" and consisting of guided instruction according to personnel in Districts Two and Five. Teachers utilized devices in ways that focused on teacher-led instruction. Additionally, in Districts One, Three, and Five, devices were used by teachers to primarily complete "clerical" or administrative tasks. Access-

ing electronic grading and student information programs were the main functions for using technology by teachers prior to implementing the one-to-one program.

When we asked district personnel to describe their programs prior to the implementation of their one-to-one initiatives, many leaders elected to tell us about their previous use of technology. One of the things we learned involved the amount and type of devices owned and how they were deployed. The commonalities among the districts included accessing technology devices through the use of carts or computer labs. In District Five there were as many as 50 labs across their 17 schools. In the District Two focus group, the use of carts was described as being cumbersome in regards to moving them from place to place and ensuring that they were charged daily. The technology platforms used by the districts varied. Some districts used technology from one vendor while other used multiple vendors. In addition to devices in labs and on carts, some classrooms in Districts Two, Four, and Five also utilize interactive whiteboards. Through our discussions with District Two personnel, they acknowledged a willingness of teachers in at least some of their schools to try using new technologies such as interactive whiteboards. This sentiment convinced them later to accept grant monies that would start their iPad one-to-one initiative.

Several districts admitted that before the one-to-one implementation, they did not have enough technology to meet student needs. District One leaders recognized that their current technology was being used at capacity. With the district's disposition for innovation, the limited number of laptops available for students made the district leaders receptive to the idea of implementing a one-to-one initiative, according to Superintendent A. District Three leaders determined there were not enough carts and computer labs to provide enough access for teachers to use technology instructionally with students. We learned that prior to the one-to-one initiative in District Two, students practiced technology with a limited number of laptop carts and in computer labs. Prior to District Five's current ubiquitous project, the district conducted a three-year pilot of one-to-one in two schools using MacBooks. However, the district leadership was unable to secure funding to continue the program utilizing the more expensive Apple devices. They went a year without any one-to-one and realized the benefits they had lost. A new superintendent was able to secure funding to finally implement a one-to-one using the less expensive Chromebook.

5.3.7 Research

Researching the benefits of a one-to-one program was a common theme among the districts interviewed. A member of District Four's leadership team spoke of reading about and observing other districts' implementations of one-to-one for over ten years to learn from their mistakes. Others took a more active role of piloting one-to-one on a small scale within the district to determine if ubiquitous computing would fit their needs.

Districts Two and Five piloted one-to-one programs before deciding to implement full-scale deployment of devices. In District Two, the fourth and eighth graders were allowed to take home Apple eMates beginning in 1998. This experience helped inform the technology director about the feasibility of students using computing devices off campus. Under the direction of a new superintendent, District Five conducted a second pilot with three platforms before choosing their current device. The pilot program helped them research which device was most beneficial to as many students as possible, given their projection for funding.

Some leaders in districts we have interviewed are exploring the possibility of "bring your own device" (BYOD) initiatives. District Two and District Four leaders spoke of the value BYOD might have for students on grade levels not currently participating in the one-to-one initiative in those districts. For District Four leaders, a BYOD initiative could inform them about what

to expect when they later might scale-up their program beyond elementary school.

No matter what type of research or pilot programs are conducted, District One leaders emphasized the importance of sharing findings with the teachers and the community. Open communication about the successes and challenges faced during the pilot programs will help stakeholders feel invested in the project and serve as a method of gaining support for the initiative.

5.4 Planning Case Comparisons

In the planning stage, seven themes emerged when we analyzed the interviews and documents across the five districts in our study. These themes are organized around three larger concepts: setting a clear vision, establishing a planning time, and outlining the steps in the initiative.

5.4.1 Providing Leadership

Providing leadership was one of the themes that emerged around the planning stage for the one-to-one implementations across the districts. Leaders in three of the districts emphasized that you must hire or select the right personnel to help in the planning of the initiative. In Districts One, Three, and Four, leaders spoke specifically about creating a team whose sole purpose would be to develop, monitor, and implement the program. In District One this team was referred to as the "implementation team," and a chairperson was appointed to lead it. District One leaders also created an initial workshop where this team met to formulate a master plan for the initiative. After this initial workshop, the implementation team met weekly to discuss their progress on each aspect within the plan. During these meetings, which continued through the deployment stage, the team reviewed important dates, time lines, responsibilities, and action items. Superintendent A from District One described these weekly meetings as a "path" to remind the implementation team of what they needed to accomplish.

In District Three, the team that helped plan the one-to-one initiative was referred to as the "steering committee." District Three leaders used a flyer to invite staff members to join this steering committee. Team members were asked to assist with all aspects of the project including planning, monitoring, implementation, and evaluation. It was an expectation that the team meet frequently to provide updates and to review the timelines so that the program would remain on schedule.

District Four's superintendent selected the team for the planning process. Due to the small size of District Four, this team consisted of two senior leaders from the technology team. They were responsible for revising the district's technology plan to include the one-to-one initiative and they planned the procedures for the deployment. District Four's superintendent spoke about the importance of selecting the right members for the planning team, but he advised that you must also give these individuals the freedom to plan and execute.

5.4.2 Developing a Clear Vision

Several district leaders in the study emphasized the importance of developing a clear vision prior to implementing one-to-one programs. In District One, it was expressed by all participants that the initial vision was to prepare students for their future, in part by eliminating the digital divide. Some leaders also mentioned the importance in exposing students to twenty-first century skills as the vision evolved under different leadership. Due to the longevity of this district's program, the vision changed informally to "providing students with the appropriate tools to gain knowledge and develop skills." They also wanted to ensure that every student had access to a personal computing device.

From District Two, a district leader we interviewed spoke of the having a vision that was driven by the curriculum and not by the one-to-one program. She stated that the devices would just

be viewed as "gadgets" if the vision was not centered around enhancing the curriculum.

From District Three, leaders spoke of their one-to-one initiative being centered around providing students with access to technology at "anytime, anywhere." The vision was to increase student engagement, and to change the classroom setting to target critical thinking and problem-solving skills. District Three's superintendent felt that the iPads would help change the role of the teacher from "the brain trust in the classroom" to more of a facilitator of knowledge in the classroom. She stated that the traditional classroom is no longer conducive to student learning.

Leaders in District Four expressed their vision to provide access to technology but with a focus on making the learning environment for students more personalized. This vision was connected to the district's mission which is "maximizing the potential of every learner." The superintendent stated that beyond test scores, the benefits of the one-to-one initiative were going to help reach this goal.

District Five leaders also focus on personalized learning in their vision statement. Student-centered classrooms that result from a change in classroom pedagogy is a goal expressed by District Five leaders.

5.4.3 Assessing Instructional Needs

Our analysis revealed district leaders based their planning efforts around instructional needs. In District Two, the director of technology said they were in the middle of updating the curriculum when the planning began for the initiative. One of the curriculum needs was replacing paper textbooks with digital textbooks. As they developed the new curriculum, they added plans to utilize iPads as the tools to accomplish the goal of providing digital textbooks to students. The technology director stated the "[iPads] fit right into our curriculum plan." Leaders in District Three provided similar insight into the planning process regarding their curriculum needs. The superintendent spoke of replacing outdated textbooks with digital textbooks and ebooks. She offered two additional curriculum-based goals, which were to have more opportunities for student engagement and to offer a larger offering of elective courses to high school students. The latter goal was addressed through distance learning opportunities coordinated between two of the high schools in the district using the iPads.

5.4.4 Obtaining Funding

In the planning stage of a one-to-one initiative, districts leaders spoke of considering which funding source to use, whether to incorporate the cost in the existing budget, utilize textbook monies with local and state contributions, or whether to seek grants. The leaders also discussed whether to buy or lease devices. Table 5-1 represents the various ways each district sourced the funding and whether they chose to buy or lease the devices for the programs.

Sources from District One stated that they were able to fund their laptop initiative from about two percent of the operating budget annually. For district leaders that chose a lease, it allowed them to receive all the technology at once rather than having to build up their supply over a period of years.

5.4.5 Selecting a Platform

Also in the planning stages of the one-to-one programs, the district leaders had to make decisions on which vendor and devices to select. Superintendent A from District One spoke of three reasons for selecting their vendor: a pre-existing relationship, the quality of product, and the company seemed best aligned to serve the educational needs of their students. This vendor was willing to give the district a favorable deal due to the volume of devices the district was planning on deploying. During the planning stages for the refresh of the devices, Su-

perintendent B from District One explained that he solicited the input of various staff members to decide whether to continue with the current vendor or to select a different one. After putting out a request for proposal (RFP), the leaders in District One selected a new vendor based upon the input of the superintendent's committee who weighed the cost of new laptops with the support each vendor would provide for repairs. By selecting the new vendor, Superintendent B's committee from District One saved $4 million over their previous contract, when moving from a purchase plan to a lease plan. District Two leaders were required to select iPads based on the grant they received; therefore, they had to work with Apple. The superintendent in District Three selected iPads because she said they provided several desirable features such as being lightweight, easily transportable, and appealing to students. The superintendent spoke of how many of the educational apps for the devices were free or could be purchased for very little cost. In District Three's written communication to parents, additional features of the iPad devices were provided to justify the rationale behind why district leaders selected the devices: wifi capability, long battery life, personalization ability, and Apple being the leader in education apps. District Four leaders expressed similar reasons as District One for selecting Apple as their vendor. The district staff were already using Apple products in their schools and district offices, and had experience managing iPads prior to their one-to-one initiative.

District Five leaders decided to rely on feedback they received from a pilot program to select their vendor and device. During the planning process, three devices (iPad, Chromebook, and Microsoft Surface) were given to three focus groups within the schools. These groups tested the devices with students for six weeks and met to discuss the pros and cons at the end of the pilot. The recommendations led District Five to select the Chromebook for their initiative, citing cost and its compatibility with *Google Apps* as strong features.

5.4.6 Selecting the Grade Levels

In the planning stage, district leaders determine in which grade levels to deploy the devices. Table 5-2 lists the grade levels initially chosen for the deployment and the initial reasons given by district leaders. Multiple districts have expanded the deployment to other grade levels after the first year.

District leaders chose these initial and subsequent grade levels to deploy after weighing factors specific to their district. For example, during the initial phase of District One's deployment, superintendent A spoke about his decision not to stagger the roll-out among the high schools was based on feedback he received from several high school principals who felt this type of

Table 5-1: *Funding Source and Finance Options*

District	Funding Source	Purchased or Leased
District 1	operating budget	purchased (initial deployment), leased (during refresh)
District 2	state e-textbook initiative and stimulus grant funds	purchased
District 3	textbook funds	leased
District 4	textbook funds	purchased
District 5	operating budget	leased

Table 5-2: *Grade Levels Selected for Deployment*

District	Initial Grade Levels	Current Grade Levels	Future Grade Levels	Initial Reasons for Grade Selection
District 1	9th - 12th (laptops)	6th - 12th (laptops)	3rd - 5th (iPads)	to prepare students for post-secondary experiences
District 2	4th (iPads)	3rd - 6th (iPads), 9th (laptops)	10th -12th (laptops)	the grant specified the grade level
District 3	9th -12th (iPads)	9th -12th (iPads)	6th - 8th (iPads)	new on-time graduation rates and online testing requirements
District 4	3rd - 5th (one school, iPad Mini)	3rd - 5th (one school, iPad Mini)	3rd - 12th (iPads)	the principal and teachers' innovative disposition and proximity of the school to the technology support center
District 5	3rd - 12th (laptops)	3rd - 12th (laptops)	3rd - 12th (laptops)	to provide technology access to as many students as possible

deployment would be unfair, given the district's desire to help all students across the county. District Three's superintendent spoke of her decision to deploy to the upper grade levels in the district was influenced by several new pressures placed on high school students, such as preparing for computer based assessments. District Four leaders chose to start with one school and just three grade levels because they believed starting in elementary school may be easier, given their current availability of digital textbooks.

5.4.7 Establishing Planning Time

Another theme that appeared across several districts is establishing enough time to plan for the initiative prior to deployment. The following table shows the amount of time each district allocated to the planning stage (see Table 5-3).

Leaders across most of the case districts we spoke with had specific constraints that forced them into the planning periods listed above. District One was an exception, and leaders from that district clearly were focused on using enough time to properly prepare for their deployment. In District Two, leaders decided to take advantage of a unique grant opportunity and had a short window of time in which to prepare. District Three leaders made their decision to purchase iPads quickly after a change in state rules on the use of textbook funds, and worked over the summer to put a plan together. District Four's leaders had articulated plans to pilot one-to-one computing in their technology plan, but budget reductions had prevented the technology team from moving forward. Under the leadership of a new superintendent, he provided a method for implementing the pilot through the use of a "new" funding source by using textbook dollars. The technology director in District Five felt additional time for planning, such as four to six months, would have been welcomed. He led his team through the plan-

Table 5-3: *Planning Time Allocated Prior to Deployment*

District	Planning Time
District 1	2 years
District 2	< 4 months
District 3	6 months
District 4	4 months
District 5	4 months

ning, preparation, and deployment stages in seven months. He cautioned us that spending too much time to plan would be counterproductive. His rationale was that with so many stakeholders involved with the decision and planning of a one-to-one program, if you wait, you would never get everyone to agree with all of the plans. He felt this would cause the project to never get started.

5.5 Preparation Case Comparisons

For the third stage of the logic model, the preparation stage, we categorized data from interviews and documents into seven themes. These themes center around updating policies to support the program, deploying the devices to teachers, providing professional development to both teachers and administrators, and making sure the infrastructure is ready for the deployment of devices to students.

5.5.1 Leadership

Leadership continued to emerge as a theme as we progressed to the preparation stage. In District Two, the superintendent made it clear that principals should be using technology as a model for teachers. Principals were told to complete classroom observations on the iPad as well as take notes on their iPad in meetings.

In addition to modeling, personnel across all five districts spoke of the role of administrative leadership in guiding teachers. When the laptops were first deployed in District One, the leadership team's goal was to have teachers be comfortable with using the devices. They encouraged the use of the laptops, both in and out of the classrooms. A former staff development specialist in District One recalled being told by a former superintendent that teachers should incorporate laptops into classroom lessons every week in addition to using their laptops after school to "do their banking" at home. In addition to feeling comfortable with the laptop, district participants spoke of the leadership expectations set for staff to use technology in meaningful ways. The Districts Four and Five leaders discussed the importance of making clear the leadership's vision of changing teacher pedagogy as a result of deploying technology to teachers and not using technology as a substitution for textbooks. District Four personnel went one step further and made it a requirement for teachers to have a professional online presence through a district sanctioned blog or social networking site to stay connected with the students outside of class time.

In addition to administrative leadership, leadership displayed by the technology coaches was mentioned in the focus group interview for Districts Two and Three. The technology coaches were given high accolades for their leadership in preparing professional development and leading change for technology integration in the classrooms.

5.5.2 Resource Acquisition

District leaders explained the need to acquire resources to support new expectations needed to change pedagogy. All five of the district staff used content management systems to meet this goal. Some systems used by the districts included: *Edmodo*, *SchoolSpace, Blackboard, Moodle,* and *My Big Campus*. Districts Two and Three also mentioned *iTunes U* as a management system that was going to help with managing content.

Another example of resource acquisition involved digital textbooks. Because digital textbooks on the iPad platform was new, the leaders in District Two told us that they needed to work with the vendors to improve the resource over the course of several years. Students in District Two now have electronic textbooks for all of the core content subjects on iPads for grades three through five. Sixth graders do not yet have all of the textbooks on their iPads. According to their technology plan, District Two leaders have also recently acquired a media streaming server to provide video resources for use to support teaching and learning.

The abundance of resources could also cause a negative effect. District One personnel spoke of some of the programs used over the years including *Blackboard, eClass, K-12 Planet, Beyond Books, Discovery Science,* and *Quia*. Many more programs had been piloted in small pockets or purchased for every school over the years. According to one interview participant, "thousands" of pilot programs were occurring before funding became tighter and the questions arose as to whether these programs were valuable to the educational learning of students. The purchase of software or equipment was even less regulated as individual schools used funds to buy games and materials. The same interview participant expressed frustration as some of these materials were not fully researched before purchase and it was later found out the software was not compatible with the technology already in the schools. District Two personnel also felt frustrated with the number and quality of apps teachers were requesting be placed on the iPads. The technology coaches expressed that some apps were not educationally focused and they questioned teachers on the applicability of the apps in the classrooms.

5.5.3 Policy

Also in line with the vision and resources made available to teachers, district leaders spoke of updating policy before deploying laptops to teachers and students. Leaders from all five districts updated the acceptable use policy (AUP) as a part of the annual review. Districts One and Two leaders augmented the student code of conduct to reflect technology use by teachers and students. Among the AUPs examined, the one from District Four was unique for specifying the consequences with misuse in the document—much like the student code of conduct in District One. District leaders from all five of the districts spoke of the importance of digital citizenship. District Three personnel created a steering committee to develop student expectations of using technology. District Five personnel also created a similar set of expectations through a committee made up of administrators and teachers to write curriculum related to student use of technology.

5.5.4 Parental Responsibilities

Federal and state regulations require district personnel to establish policies related to students. Among all of the case studies, districts took steps to ensure parents understand the responsibilities. In Districts Two and Three, parents are required to monitor student use of the school-owned device at home because there is no filter outside of the school network. In District Four, the equipment loan policy is separate and outlines the expected use, coverage, and revocation of technology in the case of misuse. The other districts have made the equipment loan policy a part of the AUP. Also in Districts Three and Four, parents sign a permission form for online accounts to be created in the students' name and parents receive advance notice before any new account is created.

To help parents understand their responsibilities, all of the districts that participated in our research provided training for parents. All parents have the option of attending a training session provided by key personnel in the districts. Key personnel often included technology coaches and building administrators. In District One, however, online training is also available. Parents read through the materials and take a quiz online. The score is then sent to administrators at the school level.

5.5.5 Deployment for Administrators and Professional Development

The deployment timeframe for administrators were similar for three districts and different for two districts. District One chose to train their administrators on managerial tasks on desktop computers a year ahead of deployment. District Five focused on training their administrators on changing classroom paradigm with two days of training, one day in the fall and and one day in the spring before the deployment year. District Four sent

the principal of the pilot school to two training opportunities in the summer before deployment. Figure 5-2 summarizes the period of time between administrator deployment, administrator training, teacher deployment, and teacher training ahead of student deployment of devices.

5.5.6 Deployment for Teachers and Professional Development

The deployment time frame for teachers was similar across the districts, as outlined in Figure 5-2. Districts One and Five spoke of challenges related to the initial training that was unique in our case studies of the districts. Both district staff had never used the devices before in a school setting and some staff members had limited experience with using these technologies at home. The initial trainings for staff were elemental and focused on very basic skills to help teachers learn to use the devices comfortably. District Four spent very little time on the mechanics of using the device due to the familiarity the teachers already had with using iPads.

Outside resources and vendors were also used to help train teachers. District Two received a recommendation from the state government on

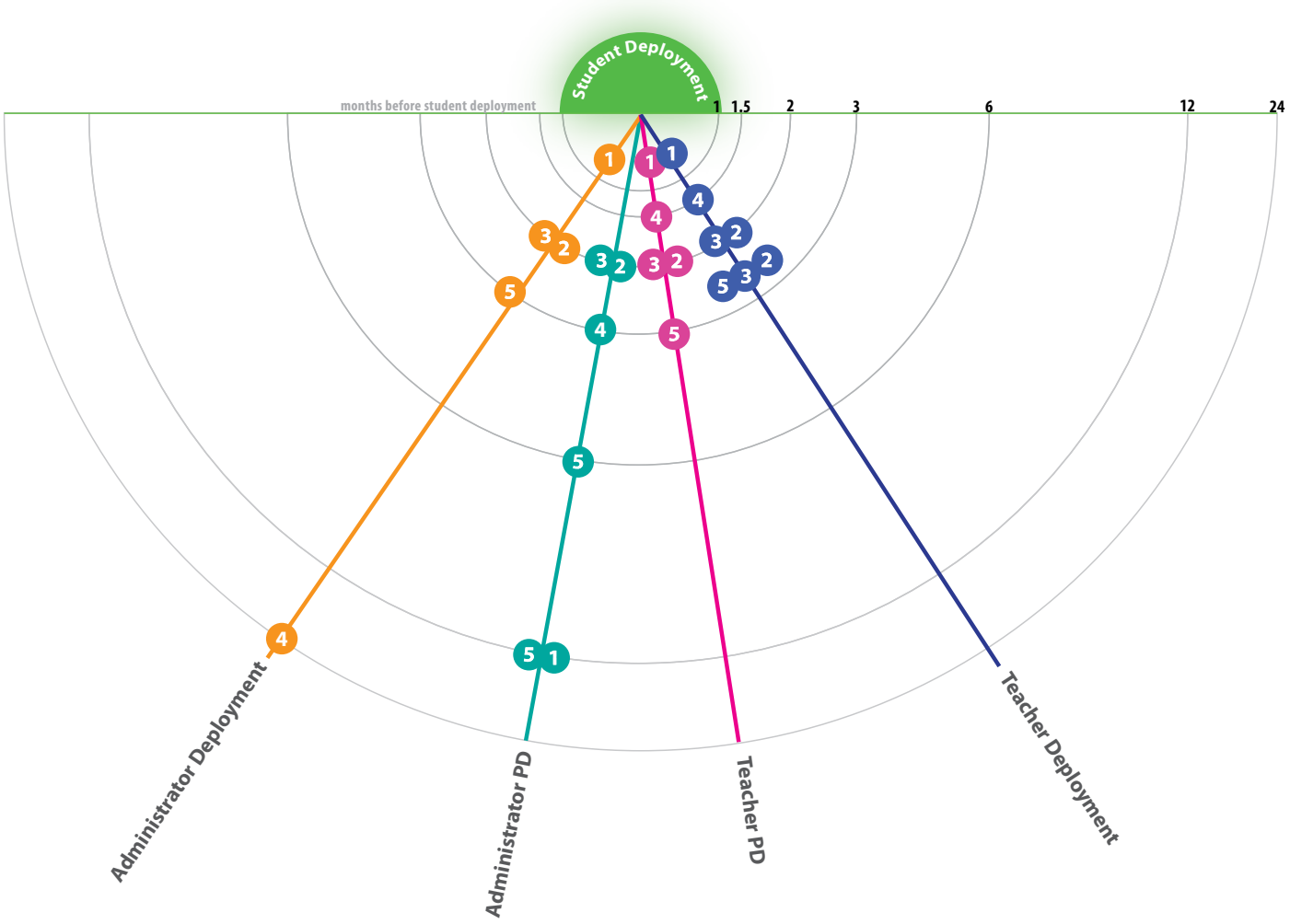


Figure 5-2. Deployment timeline. This graphic compares the pre-student deployment timelines among districts (denoted by number in each circle) for administrator device deployment, administrator professional development, teacher device deployment, and teacher professional development. The circular lines denoting the number of months before student deployment of devices are not to scale.

an outside trainer to conduct their roll out. In addition, Apple provided training to the technology coaches, who in turn could offer support to the teachers. Apple also provided training to leaders in Districts One and Three. Dell also began to provide support to District One when district leaders began integrating their product into their high schools.

One focus in these initial trainings was classroom management. Districts One and Two staff spoke about the need to support teachers in managing their classrooms when the devices were in use. In fact, building administrators and teachers asked specifically for classroom management skills from the staff development coordinator in District One. An administrator from District One recalled how teachers were so afraid of not being able to see a student's screen at all times that they put desks into rows with the teacher sitting in the back of the room. The administrator pointed out that this was not a good strategy and she encouraged teachers to walk around the room instead.

A key focus not present in the initial trainings was changing classroom paradigm, except in District Four. District Four staff spent most of the initial three-day summer training on creating opportunities for deeper learning for students. District Five later in the first year acquainted teachers during their Technology Fair on changing teaching paradigm referencing the SAMR model. District Two's Technology Conference helped teachers in that district understand technology integration into curriculum and using iPads as a tool after their first year of deployment.

5.5.7 Update Technology Infrastructure

In addition to making sure teachers and administrators are prepared for using technology in the classroom, district leaders we interviewed spoke of making the infrastructure ready for student deployment. District Four network administrators received support from Apple engineers. District Four also brought in an outside company wireless network saturation to see the current infrastructure could handle the pilot program. District One also took advice from their wireless vendor regarding the positioning of access points in their schools. The former technology director we interviewed from District One also spoke about how he piloted the integration of new networking appliances at one high school for testing before replicating the same installation in other schools. Leaders from District Three invested money in upgrading their school's Internet speeds before purchasing their iPads. The technology plan from District Two also articulated recent upgrades to the wired and wireless networks in their schools with one-to-one iPad deployments.

5.6 Deployment Case Comparisons

Within the deployment stage, nine themes emerged from our interviews and analysis of district documents. Of all the stages in our logic model, the deployment stage produced the most data for comparison.

5.6.1 Setting Expectations

During the deployment stage districts have to communicate a varying amount of expectations for the new technology, with many of these expectations aimed at students and their parents. Many districts choose to communicate expectations for how the devices should be handled, who is responsible for the device's safe handling, and details about how the devices can be used off campus. Some district leaders have these expectations articulated in their acceptable use policy, while others have generated special forms or communications, such as the *Student Memorandum of Understanding* used in District Three. This document communicates when the iPad should be put away, that the iPad should not be used to play games or access social networks, and tells students specifically they are responsible for the safekeeping of their iPad. In addition, District Three formally presented five instructional expectations for the iPad initiative with both students and parents, including stu-

dent engagement while learning, expanding learning opportunities beyond school walls, the promotion of collaboration, the exercise of creativity, promotion of critical thinking, the allowance of anytime/anywhere learning, and the provision of a new platform for making global learning connections.

District Five set very clear directions for students with their expectations, including a mandate that students call home if they forget to bring their Chromebooks to school. Disciplinary consequences are promised to those students who routinely forget their Chromebook, according to the guidelines posted on the district's website. District Four personnel reported that while some students have forgotten their iPads at home, a school-created policy allows students to call home three times. After that point, students lose their take-home privileges of the iPad. District Five also restricts take-home privileges by students who never return permission forms signed by the parents, deeming them "Day Users." Several districts also communicated the expectation that students come to school prepared to learn with their devices, ensuring that the devices are fully charged at home, or that chargers come to school with students.

Among the districts, some had some unique expectations we learned about from our interviews and in analyzing their provided documents. District Four set the expectation that students not photograph or create videos of other persons without their explicit permission. District Five prohibited their students from taking their Chromebooks to a repair service other than the school. District Three communicates to students that they may not delete apps on the iPads installed by the district technology staff, and that their iPad is subject to search "without cause."

5.6.2 Deployment Details

The cases we selected each deployed their devices in a session with parents, most at an evening event or "deployment night." Larger districts have deployed over a series of days. One district staggered their deployment by dividing up the student population alphabetically by last name, while another used different grade levels to stagger theirs. Typically these deployment windows include participation by a variety of district personnel, students, and parents. District Three employed their district administrators, principals, technology coaches, and also students to help hand-out iPads and forms to other students and their families. Through many cases we learned that fees are collected during the window. A principal from District Four told us through an interview that she had wished they did not collect fees during their deployment window meetings with parents, to simplify the handing-out of iPads and training that took place at her school. Across the cases, upon receipt of the devices, families participate in training sessions that communicate behavior and instructional expectations, the details of the district's acceptable use guidelines, and in some cases, options for participating in insurance programs and training in digital citizenship. We gathered through our interviews that district officials often aim to deploy devices at the start of the school year, although in the very first year, this target has sometimes been delayed due to the required time to prepare. District Four's leaders had made a decision to deploy iPads one grade level at a time, and held off on deploying the iPads to third graders last. Teachers reported to the principal and technology coach that they believed more class time was wasted with students learning and playing with the new devices in school since they could not do the same thing at home in the first weeks. The district's technology department later allowed the devices to go home, to the contentment of the third grade teachers.

Some districts leaders learned after their initial deployment that they had made mistakes in preparing the devices for student use. Two districts admitted that their security and filtering configuration was not adequate. In one case, the entire deployment of laptops had to be redone, by collecting every laptop before a December break, having each one serviced by the ven-

dor, and then returning devices to students upon their return in January.

Many districts utilize forms to communicate the details covered in deployment window training, which may include permission forms for student email, the acceptable use policy, and permission to have access to accounts if students are under the age of thirteen. This last permission is required to be in privacy compliance with the Children's Online Privacy Protection Act (COPPA). Several districts provided parents with "receipts" for the devices, detailing the device's model type and barcode number.

Two cases we studied put into writing for communication during their deployment window that parents are responsible for monitoring student behavior on the Internet at home. We confirmed in one case, and suspected in a second, that the district had not employed filtering technology on the devices when they accessed wifi networks off school grounds. The superintendent from District Four, we learned from our interview with him, was concerned about the policy implications when devices go home, specifically with the Children's Internet Protection Act (CIPA). This law requires libraries and districts to filter Internet-derived content for children to exclude obscene and objectionable content, when receiving federal dollars.

District One, with the longest deployment history among the cases we studied, has an automated system for deploying their laptops to students. Using barcode scanners and an electronic inventory system allows them to review district-wide reports each October to assess any needs for additional inventory after the initial deployment window is complete.

5.6.3 Collecting Fees

District personnel collected fees from students to cover damage to devices over the course of the school year. The fees varied depending on who was offering "insurance" (an outside vendor or the district), the value of the device, and whether the district subsidized the fee to reduce the burden on families. The fees ranged from $24-$50. One district required payment of the fee to take receipt of their device, with no exceptions, while another district offered an insurance fee as a "suggestion." Many districts had mechanisms for helping some families pay for the fee, such as grants supplied by a parent-teacher association or payment plans.

Some districts communicated replacement costs for the devices and accessories in case of loss or willful destruction. Communication took place through district websites, device loan forms, and through policy documents. Parents learned about the costs as part of their participation in the deployment night training session. Personnel from District Two went further in telling parents that upon learning about a missing iPad, their first course of action would be to contact the local authorities for alleged theft. They adopted this policy after finding it worked to recover a missing iPad earlier in their deployment history.

5.6.4 Student Training

While many district leaders use their deployment nights to train students on basic use of their one-to-one technology, some districts continue their training efforts beyond the deployment kick-off. District One has used online courses and websites on a variety of topics to train students, parents, and teachers, including how to organize digital files, how to perform a "desktop sync," Internet safety, how to access "eLearning" resources, printing, and using web browsers. Leaders from District One we interviewed admitted, however, that in their first year of implementation, they did not have the online training materials ready, and did not offer organized training for students. One principal commented, "We didn't do any training with the kids that first year, it was a free for all." They insisted that training is today a requirement, especially in setting expectations for digi-

tal citizenship. District Three likewise requires their students to complete training on digital citizenship online. District Four's technology coach has trained students on Internet safety basics when visiting classrooms. She has used the same venue to train students on accessing online services, such as *Edmodo* and *Google Apps*. District Five, in their first year of implementation, has provided training to students on how to provide technical support to other students and teachers in addition to topics in digital citizenship.

5.6.5 Infrastructure

The leaders we interviewed from District One underscored most deeply how important establishing a solid infrastructure was before the deployment of devices to students. At the time of their initial deployment of laptops to high school students, wireless technology was less mature as was filtering and an understanding of how teenaged students might use a wireless network in school. After their first year of deployment, the technology staff had begun to address the issues initially seen by providing more wireless access points, a filtering mechanism for students, increases in bandwidth capacity to the schools, and in addition, the staff also began employing "imaging" technology to update the laptop software. Several of the staff members present at the start of the deployment in District One underscored the importance of vendor support during their initial years. One former superintendent described the vendor specifically as "hungry" in wanting their initiative to work, and another leader confirmed this with the admission that the vendor had contributed several million dollars towards the project in trying to make the initial deployment go smoothly.

Districts Two, Three, and Four have iPads in their deployments and a different type of challenge was faced by these districts. Two leading methods for preparing iPads are through the use of a tool by Apple called the "Apple Configurator" and through another third party service called a "mobile device management" system. Few districts had complaints about their mobile device management systems, but District Two's technology director expressed her colleagues' frustration with Apple's methodology for configuring iPads at the start of their deployment. She described the process as long and as a "nightmare." We learned that the Configurator is used by information technology staff in two districts, and technology coaches in a third, in connection with a cart that "syncs" apps using USB. A technology coach admitted that, "the syncing cart was the jewel. Because you could do up to 30 at time. But still with that it is just a time consuming process." The technology coordinator from District Four shared with us that although Configurator is a newer tool to prepare iPads for use for students, it could also be better modified specifically for school use. Not unlike the team from District Two, he shared that the early deployment of iPads had been challenging, compared to experience with preparing laptops for deployment. District Three did not admit to facing many challenges with the tedium of configuring the iPads, but did admit that with their approach, they did little to configure the devices and instead trained parents on how to set restrictions on iPads at their deployment and orientation meetings.

Almost all of the case districts referenced the use of so-called cloud-based storage as a component of their infrastructure. These included both cloud storage (*Google Apps*, *Dropbox*) and content management systems for education (*MyBigCampus, Edmodo*, Angel Learning). The technology director from District Five liked the concept of cloud-based storage because if he decided later to change platforms, away from Chromebooks, their storage solution could remain intact. District Four found challenges in identifying a comprehensive cloud-based solution for their deployment, utilizing a combination of *Edmodo, Google Apps*, and Apple's *iCloud*. District Four's technology coordinator stated that no one solution currently allowed student users to "back up" all of their data at once. Because of their size, District One personnel we interviewed recounted many failed attempts to fully utilize Internet-connected services with

their laptop deployment. Some of the failures were attributed to bandwidth congestion on the school-end, to ill-preparation by vendors to anticipate the impact of so many student machines accessing their servers or network.

5.6.6 Expressions of Leadership

The deployment stage was an opportune time for evidence of (and lack of) leadership to emerge from district personnel. District One's deployment was routinely lauded by past principals and support staff as emanating from the leadership and vision of a past superintendent. Yet when we questioned one focus group of current employees from the same district about who, today is "in charge" of their one-to-one deployment, the group composed of a staff development professional, a principal, and a curriculum specialist had a difficult time in naming any one entity or department. The success of their program, they admitted, was a direct result of their past superintendent insisting that he and his leadership team see laptops in use in classrooms. More recently, they shared with us that a hierarchical change in the district separated the "information technology" and "instructional technology" departments from effectively communicating and working in tandem. A subsequent reorganization has rectified this earlier change. Another former leader from District One told us that an instructional leader "must always be over the project, never a technology director."

District Two leaders shared with us that their instructional and information or "technical" departments worked well together. The superintendent and director of technology both have set expectations with principals that their iPads be used to take notes in meetings, and to record classroom observations. Their expectations on how technology is to not be used is expressed through their acceptable use policy, banning the use of social media by teachers and students during the day, even on personal devices. Leaders in District Four differed on their view on the topic of social media, requiring their teachers to maintain blogs for student and parent readership, and allowing social networking by teachers during the school day as long as it was for the purpose of professional development, according to their acceptable use policy.

We liked the congruence of positive attitude in District Five for their technology director's thoughts on the building administrator's role in addition to their positive outlook on digital citizenship for students: "Our administrators' goal is to empower teachers to be courageous and to take risks, to get out there, and explore [with technology]."

In the midst of our focus group session with District Three personnel, we saw an expression of leadership come from their director of secondary education, who later took credit for being a leader for their iPad deployment. His admission that in the first year his use of a "heavy hand" with decision making about the iPads led to unnecessary mistakes. He praised the technology coaches in attendance and insisted that the best policy is to put decision makers in closest proximity to students: "[you] need to consult with folks on the ground" and "utilize experts in the building[s]."

District Four's superintendent praised the quality of personnel on their technology team to making a one-to-one project successful. He went on to describe his leadership approach towards the project:

As a leader, one of the things that I try to do is hire great people. And, let them do great things. So, I kind of stayed in the loop enough to know whether we were making mistakes or not. Whether we were properly spending funds. But, I really trusted the instructional team and the technology team to really plan out the best way possible.

5.6.7 Instruction

Our case districts provided a wide variety of evidence towards

the state of instruction across all of their schools. The districts varied too in their instructional approaches and goals. Districts One and Four today promote so-called twenty-first century skills in their instructional model. District One provides a progression chart with examples of what instruction looks like when these skills, such as "problem solving," are being exercised in the classroom by students and teachers. District Four provides a planning framework to help apply a similar set of skills in a project-based approach, advocating for students to create a product or artifact of their learning.

Both District One and District Five leaders praised the role technology has in assessment. District One, in particular, was able to deploy more tests using laptops than was possible with pencil and paper. The deployment of iPads in District Two was praised by their state's board of education, and state officials chose District Two for one of the state's first trials of standardized tests delivered on iPads with students.

The instructional model employed in District Two by their administrators varies among the grade levels of the schools. Elementary and middle school instruction is focused around the use of digital texts installed on the student iPads. Some high school instruction is focused around the NewTech framework, creating new hybrid classes with project-based methodology. The district felt laptops better supported this model and therefore is deploying MacBook Air laptops for students for the first time this school year. District Two leaders also spoke about the great benefits of mobile technology such as the iPad for special education students with individualized education plans (IEP), citing its adaptive and assistive capabilities.

District Three leaders shared their vision for instruction through slides created for their deployment night for parents. The slides referenced higher levels of Bloom's Taxonomy, "responsive teaching," purpose-driven instruction, and mastery of skills and content. District Three's superintendent also shared her vision of moving away from "cemetery rows" of desks in classrooms and creating more engaging experiences throughout her schools as part of her instructional vision. This included allowing teachers to leverage the student iPads to help students connect with other learners in other parts of the world.

Both District Four and District Five leaders have referenced an instructional continuum called SAMR (Puentedura, 2013) to help identify how they are progressing with instructional goals. Initially, the technology director from District Five described their use of technology as the first stage in the SAMR model, where technology use is a substitution for a more traditional analogue (such as paper). Five months into their deployment in District Five, the technology director expressed that there were early signs of instructional growth, with an expressed desire by teachers to make learning more student-centered. The director also observed movement in the classroom of project-based and inquiry-based instruction. The district's new three technology coaches were praised for helping make this change take place.

5.6.8 Professional Development

Our analysis uncovered strong evidence of training to parents and to staff with new one-to-one technology. Parent training typically takes place at deployment nights with teachers, technology coaches, and administrators, and covers operation of the devices in addition to other topics, including the vision for the program and digital citizenship. In many cases, this training was done in tandem with students. Parent training in several districts was available online, through video, courses, or informational webpages. In subsequent years because of their longer history of deployments, personnel in Districts One and Two reduced the amount and time on professional development for parents.

Many district leaders utilized summer vacations to offer training for teachers. For initial deployments, this training often

focused on operation of the devices. Trainings in subsequent years focused on instruction. Training continued to be conducted during professional development days, after school, and during school hours during the school year. From District One, Superintendent A shared with us how popular the summer training opportunities were with teachers, in part, he believed, because they were paid.

Many district personnel we interviewed, across the case districts, spoke of the need to differentiate professional development based on teacher needs. District One, where the staff we interviewed shared they had a strong staff development department before their one-to-one deployment, always followed training sessions with surveys for teacher-participants. This feedback helped trainers design the next session, or to recommend different sessions to different teachers. District Two technology coaches told us that they differentiated their approach between their different schools, finding more secondary teachers asked for support online, through a chat service, rather than with in-classroom modeling. District Three differentiated their training during the school year with both short and long sessions, respectively called "snacks" and "meals." More teachers, they found, preferred the shorter training sessions. The District Four principal we interviewed said she provided training sessions for each grade band in her school. For those sessions during the school year, she hired substitute teachers for the regular classroom teachers to spend half-day sessions with their technology coach and the district's supervisor of instructional technology. In District Five, the principal and technology director we interviewed in a focus group articulated their support for differentiated training for teachers. They have focused upon grouping teachers in training sessions based upon their "technology readiness." Technology coaches in District Three told us they did the same thing. The smaller teams in District Five later regroup into larger teams and share about what they learned for the benefit of the larger group's perspectives. Sharing also takes place among teachers in District Three. According to the principals in our focus group, their teachers participate in sharing sessions about the use of technology in instruction at faculty meetings.

Personnel from each case district endorsed the effectiveness of the role of the technology coach in supporting their programs. Tasks for the technology coaches include demonstrating the use of apps and software, providing "just-in-time" support by answering questions, co-planning lessons with teachers, delivery of lessons to students alone or with teachers, and by providing resources for independent learning by teachers such as "how-to" guides and videos, or links to online learning resources. In District Five, teacher leaders augment the role and reach of technology coaches to provide similar types of instructional support.

Four of the five case districts we interviewed also spoke of using vendors to help provide professional development. While the type of training varied between vendors and districts (both technical and instructional support was articulated), all of the case districts described this training in the initial phases of deployment, with an eventual preference in moving toward the district's own personnel for training support.

5.6.9 Support

The level and type of support offered at the school level across the case districts varied. District One personnel were forward thinking, we believe, when they chose to fund one support and one coaching position at each school with their one-to-one deployments. District Five, likewise, has placed a technician at each school. District Two's technology director has hired an equal number of technicians for every coach. A clear picture of technical support did not emerge in our study of District Three, but it was clear in our interviews with technology coaches that they played a large role in the configuration and preparation of their iPads for students. District Four's leaders have appointed a

part-time coach and a full-time librarian in charge of support at their pilot elementary school, with no officially designated technician, aside from the district's coordinator of technology. Personnel from District Four were the most vocal about their concern about the lack of positions designated to support their program. District Five only hired three technology coaches for their instructional support, but they also augment that role for training purposes with teacher leaders.

One former technology coach we spoke to from District One shared with us how important it was to develop trust with teachers to make an impact. While she knew her role was not to "fix printers," she nevertheless would perform that task for teachers she had not yet collaborated with to gain their trust: "all those little things I [did], to build a relationship with people." She later found the same teachers would soon approach her to ask about how to do things on a more instructional level.

District One primarily provided technical support to students with their laptops through "help desks." Designated areas in their middle- and high schools were available for students to drop off broken equipment, and either get immediate troubleshooting support, or else receive a "loaner" device for use while the original device was sent for repair. As the program in District One matured, student helpers and workers were brought in to help provide service to their "customers." District One technology staff also augmented the supply of loaners to try and meet demand after several years and changing vendors.

While the personnel from District Two did not specifically identify student workers to help support their initiative, the principal we interviewed did speak to the importance of building character in students to treat the technology with respect, thereby reducing incidents requiring technical attention. Over the course of four and a half years with iPads, the personnel in District Two could only recall replacing six iPads. District Three technology coaches shared with us that they use a team of student volunteers to help provide support, whom they call the "iGuys." The students were on hand during deployment nights as well. District Five likewise uses student assistants who can analyze and fix some problems, otherwise they can escalate issues up to the technology department. The technology director from District Five admitted to us that their choice of Chromebook model, because it was made of plastic, was poor. The district contracted with a local firm for providing support, but is currently not pleased with the wait time for repairs—sometimes up to three weeks. He also admitted that he and his team were shortsighted for not ordering additional Chromebooks to use as "loaners" in their initial deployment.

5.7 Evaluation Case Comparisons

Similar to the communication process of the logic model, there are opportunities for evaluation in each stage of the model beginning with planning and continuing through the duration of the program. Each stage of the model consists of components that can be evaluated by district leaders through either formal or informal methods. Some districts have treated evaluation as a distinct stage, the last step in the pilot program. Others have had various evaluations conducted throughout their implementation, including comprehensive evaluations conducted by outside evaluators.

5.7.1 Evaluating the Planning Stage

The planning stage outlines the "master plan" of a one-to-one initiative. After strategizing the master plan, district leaders evaluated the different steps to ensure continued success of the program. Evaluation at this stage was undertaken informally by districts before moving to the Preparation Stage. Districts across our case studies completed the steps articulated below.

5.7.1.1 Forming vision

Each district in our study espoused a vision for their implementation. District leaders chose a vision based on the needs

of their district and articulated that the success of the program was tied to the vision. During our interview sessions with various personnel in District Four, they were able to communicate the vision for the district's initiative as fostering deeper learning for students through changes in teacher pedagogy. The superintendent stated:

You know we are not necessarily about making sure every student passes the test, as much as we are about making sure that we know where every student is when they come to us and take them to the maximum where they can be at the end of the year. I think that's going to lead in time to more personalized learning environments.

The vision for District Two focuses on improving and enhancing curriculum to prepare students for a high tech future. A principal in District Two articulated how the vision guides their practice in her district:

I think you will see when you read our vision 2018, it's not just about technology. Technology is that other piece that creates the whole child, the whole instructional process for us. So for me, I think in our school, we have good test scores and I think there's certain things we do and certain programs that we use that we have so much more access to because they all have an iPad.

The leaders from District One demonstrated that a well communicated vision ties all involved to work together towards a common goal. All participants in the interviews were able to articulate and reflect on the goal of closing the digital divide, even after a decade into the program.

5.7.1.2 Setting performance measures

A part of evaluating the effectiveness of the initiative involves setting the performance measures. These measures usually align with the vision and mission of the district. Our analysis of responses from district leaders revealed that some district teams developed these measures before deployment. In District One, writing was an area identified at the start of the initiative by staff to be a weakness and technology was used as an instructional tool. Under the leadership of Superintendent B, the district formed performance measures with a team of teachers and administrators in the district's second phase of deployment. A result of that collaboration was a new goal for instruction and evaluation focused on teaching online research skills. In Districts Two and Four, student engagement was identified as the key measure for technology use by students. District Three leaders looked at measuring high school graduation rates after the first year of implementation. District Five is working to identify measures as the program continues to mature. The district's technology director commented: "We are dealing with something that's very hard, learning is very hard to measure. Measuring the success of this is a huge, [it's the] whole picture that we are looking at. Part of it is going to be how teachers are integrating technology."

5.7.1.3 Securing funding

District leaders in our interviews identified a variety of ways to fund the initiation of their program including grants, operational budgets, and textbook funds. As some of the district leaders realized additional funding would need to be located to continue with the program, thus leaders had to re-evaluate their funding source. District Four personnel used textbook monies for its pilot program. To prepare for next year, when the program is slated to expand to include two other schools, leaders in the district are seeking additional funding. District Two leaders began the one-to-one pilot with a state initiative. As the program grew over the years, District Two staff used stimulus funding. Now the vendor wants to purchase the technology back and lease new versions to the district, a plan the director of technology is entertaining as a method of continuing the

program. Leasing was an attractive option to the technology director from District Five. He told us he would recommend it to other districts; leasing allowed him to provide all of the district's Chromebooks at one time instead of using a staggered deployment schedule.

5.7.1.4 Planning for deployment

Determining the grade level and scale of deployment is a part of the planning process. District leaders in our interviews gave various reasons for the decisions made related to grade level, type of platform, and whether to conduct pilots or go full scale. In evaluating their choices, leaders in District One were able to articulate the vision of closing the digital divide as the main reason for conducting full scale implementations at the high school level. District Five chose to deploy Chromebooks to all third through twelfth graders in order to bring technology to the greatest number of students. Major deployments at large scale, in hindsight, were not recommended by some District One leaders. One leader in particular told us it might have been smoother to deploy devices school by school, rather than all at once. Another leader from the same focus group was interested in the choice by another district to deploy devices starting in middle school, instead of high school, to start an initiative.

5.7.2 Evaluating the Preparation Stage

During the preparation stage, district leaders make policies, deploy devices to staff, organize initial professional development, and evaluate the infrastructure for student deployment. District leaders who participated in our interviews were able to reflect and evaluate on the effectiveness of their preparation.

5.7.2.1 Reviewing policies and regulations

District leaders modified their policies and regulations as they anticipated and later experienced the impact of technology on student behavior. In District One, the policies related to technology use and discipline were revisited multiple times over the decade of participation in the program. Before the implementation, policies surrounding technology use by students were minimal because students were limited to using lab computers in school. District leaders added filtering regulations mid-year of the first year of implementation and in the subsequent years saw a great decrease in technology related discipline issues. Currently, technology use and student behavior expectations have been streamlined as the technology AUP is a part of the student code of conduct. In Districts Two and Three, students were deleting the apps on iPads. As a reaction, both districts placed a ban within the policy of deleting county-provided apps. In addition to school board policy, district leaders from experienced districts have also improved deployment procedures and forms from one year to the next based on feedback from teachers and parents.

5.7.2.2 Deploying to staff

Classroom teachers received their technology anywhere from less than a month to three months before student deployment in all of the districts we studied (see Figure 5-1). District Three staff gave their technology coaches their devices one year ahead of the students. After deploying devices to staff, district leaders who participated in multiple phases of deployment reflected on the time teachers have to train with devices before students receive them. In District One, teachers in the first phase of deployment received laptops less than a month before the students. After realizing the value of giving teachers time to learn to use the laptops for instruction, the district leaders handed out laptops to middle school teachers in the second year three months ahead of their students. The District Five technology director reflected that he wished teachers had had six more months with the Chromebook before having to use them with students.

5.7.2.3 Providing professional development

Administrators and teachers received training on the mechan-

ics of using their devices as well as how to use technology as a part of an integrated classroom lesson. Some district leaders realized the importance of having administrators comfortable with using technology early on. Districts One and Five began training their administrators about one year before teachers received their devices.

Leaders in all of the districts took feedback from staff as they continued to modify professional development. In District One, staff frequently evaluated professional development with quick surveys after each session. All of the district technology coaches spoke of offering individualized training to teachers who ask questions through email, face-to-face, or instant messaging. A District Three leader advised us in making sure teachers were ready and comfortable with technology before moving onto the next steps in professional development. He recommended, in hindsight, of having a bona-fide planning stage and training stage before deploying devices to students. In line with providing targeted professional development, the technology coaches in District Three took a baseline measure of the teachers of what they already knew or have already done with technology. They plan to utilize this baseline data from the teacher technology literacy assessments to help create appropriate professional development courses.

5.7.2.4 Assessing infrastructure capability

All districts interviewed made adjustments to their infrastructure before deploying devices to students. District One brought in outside experts to help check the infrastructure. Although district leaders updated the infrastructure the best they knew how, student deployment brought on unanticipated challenges that required quick re-evaluation by leaders. In District Four, technology staff told us they had to reconfigure their filter to prevent students from updating iPads to Apple's latest operating system that was not yet supported by the district's mobile device management system.

5.7.3 Evaluating the Deployment Stage

In the deployment stage, the students received their devices and teachers began using one-to-one technology in classrooms. Districts who have participated in more than one year of deployment gave insight into the changes made to better enhance the process.

5.7.3.1 Deploying to students

District leaders who participated in a second phase of deployment, such as in District One, evaluated their first year to help make the second phase easier. One principal recalled that the process of handing out devices to students went very smoothly in the second phase and that the parents were well informed of the procedures. District Four staff staggered their student deployment, creating an opportunity for reflective adjustment after each deployment night. After handing out devices to all fourth and fifth graders to take home in the pilot school, the district chose to delay the last deployment night for third graders. District Three technology coaches reflected that the paperwork required to be signed by parents was a "logistical nightmare" in the first year, but it went much better in the second year due to better preparation. The staff also realized a differentiated approach was needed when deploying to several schools: "There is a need to be flexible about how you handle everything; every school isn't the same; you must tailor procedures and logistics based upon the personalities and past experience in your school."

5.7.3.2 Changing teacher pedagogy

All five districts that participated in this study implied through their discussions that the acquisition and deployment of technology was less about the devices and more about the opportunities and possibilities that could be realized with the use of technology. In an interview, Superintendent B from District One indicated that it was about the tool and what could be

done with it, "not the technology for the sake of technology." This shift in paradigms is a gradual process. Based on their one-to-one program experience, District Two personnel stated: "To use the iPads in the classroom with fidelity takes time." In evaluating the change in pedagogy, leaders in District One and Five created rubrics to help administrators gauge teacher technology use. Although not currently a part of formal evaluations, the technology director from District Five stated that future evaluation procedures will integrate their rubric. A District Four leader spoke of collecting informal anecdotal evidence through observations of classroom teaching that showed promise since their deployment of iPads.

5.7.4 Evaluation Stage

In the evaluation stage, district leaders review the performance measure that was chosen in the planning stage and reflect on the year to make changes for next year or be ready for a scale up in another grade level or school.

5.7.4.1 Evaluating performance measures

Performance measures that were chosen by districts in the beginning of the planning stage were revisited during evaluation stage. District Two and Four measured student engagement with classroom observation data collected by administrators. Four years after implementation, District One staff used an outside evaluator that showed test scores increased on most standardized tests. In subsequent years, several doctoral research studies and additional outside evaluations had been conducted in District One. Some of these studies were shared with the community as evidence of the positive outcomes from the initiative.

5.7.4.2 Assessing for scale up

At the end of the first year of implementation, District One reflected on the positives and challenges of the initial year to improve deployment in their second year. Because of their pioneering deployment of iPads, District Two staff expressed the challenges they had in the beginning of their implementation. However, as the expansion of the program continued to other schools and grade levels in District Two, the process became more streamlined. District Four hopes to learn from the pilot year before expanding to other schools.

5.7.5 Evaluating the Communication Process

District leaders we spoke with across the case districts did not articulate much in the way of how they had evaluated the communications process, which we cover in more detail, below. Indirectly, through the use of surveys with stakeholders such as parents, teachers, and students, district leaders can assess the result of their communications effort. Two examples relating to communication did surface, however, in our data collection. The first came from District Three, where the superintendent recounted to us a student who had spoken publicly about "not needing" her iPad. The public admission worried leaders, until they had conducted a survey with the community, that showed a positive acceptance of their initiative. It underscored for leaders in District Three that survey results could become a powerful tool for broadcasting positive communications in the face of criticism. The second example came from District One, after Superintendent B had come into office. The criticism his district was facing, he shared with us, for a variety of reasons, was not helping the continuation of the ubiquitous computing program. In order to improve the communications ability of his district, he hired a full time communications manager with experience in the television industry. As with the example in District Three, Superintendent B in District One used survey data to promote a positive message with objective information in the face of criticism.

5.8 Communication Case Comparisons

For the communication stage, we used self-selected themes to describe findings dealing with communication prior to,

and during the one-to-one deployment. During each of these meta-phases, comments from district leaders often focused on a particular audience for communication, including the community at large, parents, the school board, and students. This disposition of thinking about communication, in a one-direction orientation to parents or to students, is not meant to undermine the importance of receiving communication from the same stakeholders. All of the case districts chose to use parent surveys, for instance, in collecting data from parents to make better-informed decisions, or in the case of District Five, to learn more about the parental attitudes about their district. District Three used a parent survey with a high return rate of 74% to learn that 76% of families had Internet access at home, illustrating how districts can use survey instruments to inform the possibilities for instructional applications with deployment.

5.8.1 Pre-deployment Communication

Our case districts used a variety of means to start discussions about their plans for one-to-one computing. These included a diverse set of venues, including school board meetings, budget meetings, town hall talks, parent-teacher association meetings, and through strategic meetings with community stakeholders, including the local chamber of commerce, a county board of supervisors, or the county's director of economic development. The two districts with the more recent deployments, also used online video and social media to communicate to parents and other community stakeholders.

Pre-deployment communications by district officials included marketing efforts, to help parents and community members better understand the vision and instructional goals of one-to-one computing. In District Two, parents were told that the instructional purposes behind their iPad deployment were for "reading, history, science, and math textbooks, educational apps, presentations and projects, and access to the Internet." District Three leaders shared with us that they believed it was important for community stakeholders to hear about how a "one-to-one" would "make instruction different" for students. They admitted, however, because of their quick deployment, some of the effort for selling the vision took place after the devices had already been deployed. The superintendent in District Three shared with us that she utilized every opportunity after the decision had been made to "go one-to-one" to communicate with parents and community members.

Staff we interviewed in Districts One, Three, and Four expressed concerns about the money used for ubiquitous computing when planning their communications. Specifically, District One faced the need to address the cost of their program during a renegotiation of their vendor contract, four years into their program. District Three leaders admitted that they launched their initiative amid a "contentious budget process" which made advocating for the new initiative difficult. District Four leaders believed that marketing the project with positive communications from the start would help stymie any potential "pushback" from parents.

Leaders from our case districts also scheduled communications specifically about their programs through their deployment windows. Deployment nights included opportunities to share the vision behind the program, conduct training on use of the device and Internet safety, and to answer questions relating to the deployment, including insurance and replacement costs.

The technology director in District Two spoke of a positive meeting she had with the Board of Supervisors. The director personally showed the members of the board how iPads were to be used in classrooms. District leaders across our cases also utilized websites to share information and gather feedback both before and after deployment.

5.8.2 Post-deployment Communication

More than in any other case we studied, the leaders from District One promoted the idea that communication both before

and during the deployment was a critical factor in the program's success. After their deployment, they utilized the community's local access cable channel on television to promote their initiative. One current principal, whose role was a teacher during their deployment, shared with us the memory he had of recording model lessons in his Spanish classes with laptops for inclusion on television. Other leaders who took part in the same focus group discussion agreed that the programming that aired on television was a public relations effort to show a more authentic view of what the district's administration had agreed upon for its vision.

District One leaders also shared stories of past graduates who shared positive outcomes from their one-to-one experience once they had graduated and either started work or higher education. Especially during the start of their deployment, they heard from students who reported being better prepared for college work, and in general, just using a computer, compared to their classmates from other high schools. District One leaders also shared with us the importance they placed on talking with students and teachers to learn about how they felt as the program developed. District leaders in both Districts One and Three used focus groups with students to help them gauge the progress of ubiquitous computing in their respective districts.

We discovered in visiting the websites of our case districts that some chose to explicitly share details of their one-to-one deployment experiences with the public. In particular, Districts Two and Four have published lists of the apps used on their deployments of iPads to students. Although to varying degrees, many of the districts chose to share content that was initially shared during training sessions, including the rationale behind the one-to-one program in question, the answers to frequently asked questions, rules for using the devices, and training materials for teachers, students, and parents. Three of our case districts also leveraged blogging by teachers as a source of communication about the initiative itself, or in conjunction with classroom activities.

5.8.3 Criticism

Across all the case districts we visited (in person or virtually to conduct focus groups and interviews), district leaders often had a positive reflection of their experience with one-to-one computing. No one, as an example, felt one-to-one computing was a waste of time or effort. Through every case interview or focus group, we heard about the positive outcomes their particular one-to-one program had for students, either through a presentation of test data, survey data, or through stories illustrating benefits. The existence of criticism, however, did surface in more than one interview, either from school board members, staff, or from parents.

We interviewed one former instructional technology leader from one district who alleged that his peers in his district purposefully obfuscated details about chargers for the devices deployed to students that could not be adequately tracked, requiring multiple thousands of dollars of extra expenditures. Since the details of the missing chargers was not widely known, the public never learned about the true cost of their ubiquitous program.

The same former leader shared with us his view on the role the media can play on characterizing your program, if not the importance of leveraging the power of your school board.

I think justifying the [public relations] stuff to the parents and the community as a whole is a really complex and difficult thing to do because—for a variety of reasons. Media is not all that interested in 'feel good' stories. But if you get a little bit of drama with one particular person then that blows up, elevates to the school board level... Then somebody makes a general policy statement based on a [single] incident. This anecdotal stuff drives a lot more of what we do then it certainly should. So all that's hard. [You have

to be] educating your board. School boards are not bright people as a whole. And there, it's like mediocre politicians. If not poor. [School board members] are not what I really look up to in terms of my aspirations for people guiding the future of our educational system.

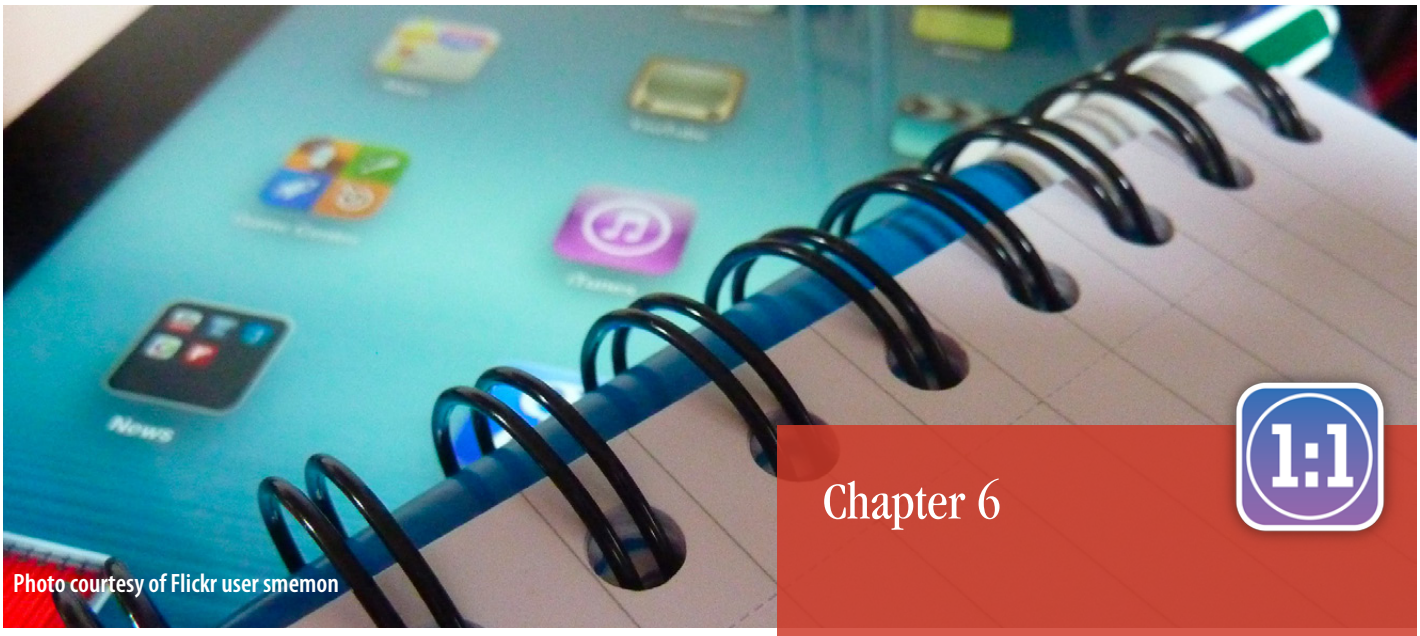
When we interviewed a former superintendent from the same district, he stated that a school board member was interested in "removing all technology" from the district, after the deployment was underway. The board member allegedly used a new budget cycle and the cost of continuing the program to garner support from the community. At that time, the district conducted a survey to find that, on average, according to the former superintendent, twenty percent of the community was "dead set against the technology." The district continued the program as it better leveraged its communication efforts to promote a more positive picture of what their program had accomplished by hiring a communications professional with television experience, as mentioned earlier. While stories about security violations by students had previously appeared in the local paper, this superintendent did not believe that the program ought to be changed because of the misdeeds of a small percentage of students.

District Five leaders used their school board meetings to communicate about their deployment, and to avoid miscommunication among stakeholders. Even though leaders in District Four encountered criticism from a parent on a wide variety of issues related to the program, including the security provided on the deployed devices, they believe it is important to engage stakeholders early and to get parents comfortable with open communication to ensure the success of a ubiquitous computing program.

5.9 Conclusion

We learned that district leaders each took their own path towards ubiquitous computing because of differing needs, challenges, and choices made in regards to platform, grade levels for deployment, and funding. Analyzing collectively transcriptions from the interviews and focus group sessions conducted in each of the five districts, and documents related to the computing programs collected from districts, we used a logic model to compare evidence from each case. Our goal was to look for practices to replicate and practices to avoid to illustrate best practices when implementing a one-to-one deployment. While the development of our logic model was used to analyze one-to-one programs that have already been implemented, it may also serve as a guide for implementing a new initiative.

Discussion & Recommendation



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Chapter 6

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6.1 Introduction

Our multiple case study approach focused on the challenges and successes of five districts as they began the implementation of their ubiquitous computing initiatives. Using our logic model as our guide, we analyzed the paths taken by the different districts in their journey. We found that district leaders touched on all stages of the logic model, although to varying degrees. Depending on the timeframe districts had before student deployment, we found some district teams did not spend much time in the **discovery** and **planning** stages. District leaders spoke more regarding challenges that arose in the **preparation** and **deployment** stages. Making sure all aspects of the program were working in synergy to get devices into the hands of students brought up many reflective opinions from district leaders. Another important stage, the **evaluation** stage, was still in its infancy for some of the districts we inter-

viewed. There was little reference to a baseline or initial performance data available so districts could make comparisons in the future. However, all districts did complete internal surveys to gauge the effectiveness of the program and one district even consulted outside evaluators. During the **communications** process of the logic model, district leaders spoke of receiving varying degrees of support from teachers, parents, and community members. In some districts, leaders had to contend with negative media press as a part of their challenge.

In this chapter, we reflect on our analysis of the data and make several recommendations as it relates to our three research questions. The primary research questions for this study are:

1. What policies and procedures do districts have in place to support the success of their 1:1 computing initiative?

2. What professional development efforts were undertaken in districts with 1:1 initiatives to promote success with deployment and instructional goals?

3. What challenges do districts identify in their implementation of 1:1 initiatives?

6.2 Policies and Procedures

In our study, districts implementing ubiquitous computing initiatives had many policies and procedures to support technology use for staff and students.

6.2.1 Acceptable Use Policies

Our analysis of multiple acceptable use policies (AUP) revealed that case districts develop their policies to support the current technology resources that are available to students and staff. The AUP documents included detailed information regarding how school district leaders intend their students and staff members to utilize provided technology resources. Through our interview and focus group sessions we learned that districts typically update their policies annually to accommodate novelties with consumer technology and social behaviors such as cell phones, personal gaming systems, and social media.

Districts that were in the earlier stages of their one-to-one program indicated they have not yet changed their AUPs to reflect their ubiquitous initiatives. They were taking a "wait and see" approach to determine what changes were needed before modifying their policy to address potential issues related to their one-to-one initiative. Contrariwise, District One—the case with the longest experience with one-to-one computing in our study—has an AUP that dictates when student laptops must be returned, that decorations may not be affixed to the exterior of the laptops, and that district personnel reserve the right to inspect content on the laptops at any time.

6.2.1.1 Recommendations

District AUPs should be updated to reflect one-to-one programs. An initial step for updating would be to research other districts with ubiquitous initiatives. Additionally, identifying and gathering data about use and misuse of devices, during pilot or initial deployment, could be conducted to inform revisions that are made to the acceptable use policy for both students and staff members.

6.2.2 Discipline Policies

The overall responses that were received from participants of our interviews and focus groups indicated that revisions were made to the student code of conduct to address anticipated behaviors associated with the one-to-one initiative. Participants from District One referenced the addition of a new section to their student code of conduct solely dedicated to addressing infractions and recommended dispositions related to technology use. District One policies identify rules that dictate the use of headphones, and the prohibition of running applications off

USB drives. The literature confirms that if the use of technology is relatively new to students, then an update to the behavior policies is likely warranted. A combination of lucid policy, communicating clear expectations, with solid classroom management skills can curb discipline issues. In addition, we concluded through our research that student misbehavior utilizing technology is commonly associated with classroom management issues. One district spoke of the struggle of training teachers on how to monitor a classroom full of students using laptops. Teachers with poor classroom management skills were more likely to have behavior issues with students related to use of technology according to the literature.

6.2.2.1 Recommendations

District leaders need to plan for revising the code of conduct to address undesired behaviors by students. The code of conduct should repeat expectations articulated from the AUP combined with consequences for non-compliance. Policy can guide the support given to teachers through training to strengthen classroom management strategies.

6.2.3 Expectations and Responsibilities

District personnel recognized the importance of teaching students their role in being responsible for the actual devices as well as being responsible when accessing online content. Guidelines were developed to prepare students on the care and proper use of their devices. In one district students were expected to keep their device in a protective case when not in use.

In our studies as well as in the literature, parents are charged with accepting a level of responsibility regarding their child being issued a device. In most districts, parents are required to participate in training or an orientation session either in person or online in order for their child to receive a device. In addition, parents sign forms that indicate their acceptance of the terms of use for the devices and financial responsibility for damages to or loss of the device. Digital citizenship has also been part of the content shared with parents during deployment events. Additionally, parents have been given the responsibility of monitoring student Internet use when their child is using the device at home.

Technology integration is an expectation placed upon all teachers in the districts included in this study. Districts reinforce this expectation to varying degrees. The technology director along with principals in District Five are considering a rubric that will be used as a tool for identifying a teacher's technology integration level and in the future be used as a part of the teacher evaluation process. District One leaders have already been using a rubric and have integrated it into their teacher evaluation process. District Four is considering technology integration through a lens of student engagement, which they measure with a walk-through instrument they have developed for observing classrooms.

6.2.3.1 Recommendations

Ensuring that parents and students understand their responsibilities regarding care and use of devices needs to be established prior to distribution. Expectations should be clearly written and signed by parents and students as a part of mandatory training offered face-to-face or online. District leaders also need to communicate clear technology expectations for teachers. These expectations can be expressed in an employee handbook or as a part of an evaluation plan. Using a methodology of measuring technology integration, districts can embed this as a part of teachers' continual growth process.

6.2.4 Internet Safety and Digital Citizenship

Filtering policies are in place in districts to protect students from accessing inappropriate material on the Internet. One district in our study initially did not filter content. Consequently, issues arose regarding students accessing and downloading inappropriate material. Currently all districts filter student de-

vices, as required by Federal CIPA regulations, while connected to their school network. Two districts in our study do not filter devices when the devices are used at home. Parents are explicitly required, following district policy, to monitor their own children's Internet use at home in those districts.

Each district provides digital citizenship information to their students. Some of the expectation for using technology include asking for permission before photographing others, not sharing personal information online, and being mindful of leaving "digital footprints."

6.2.4.1 Recommendations

Prior to deployment, district leaders need to ensure adequate filtering is in place to protect students from the plethora of inappropriate content available online, while continuing to allow teachers and student access to educationally meaningful content. Districts should keep filtering enabled when students are off the school network and communicate all of these security measures in the technology plan. In addition, communications to parents should outline the limits of the filter's capability. We suggest that parents play a role in monitoring their child's access to the Internet at home. Digital citizenship curriculum should be collaboratively created and delivered by a team of teachers, technology coaches, and administrators. Districts may want to include mandates in their technology plan to teach digital citizenship to students.

6.2.5 Loan Procedures and Fees

Personnel from each district developed procedures for collecting fees and determining the amount parents would pay to provide financial protection for families against device repair. The use of fees varied amongst the districts in this study. Some districts self-insured devices, while others contracted insurance services through a third-party vendor. The costs incurred by the parents ranged from $24 to $50; we attributed the differences in fees to the differing values of the devices deployed in each district, and whether or not the district was self-insuring or not. Some districts have a payment plan or fee supplement policy in place for parents who cannot afford the fees. The technology director from District Five indicated that the technology fee parents paid was for leasing the device and also included insurance that covered accidental damage with unlimited claims, and no deductible for parents. The parents could secure additional insurance coverage to include theft and vandalism through their personal homeowners or rental insurance. Other districts expected parents to cover the cost of the devices if they were lost or stolen.

6.2.5.1 Recommendations

Leaders should provide parents with specific loan agreement details, especially as they relate to what a possible fee covers, and what expectations there are for lost or damaged devices. Leaders likewise need to consider the ability of all families to pay fees, and consider alternative methods for covering insurance, if required. These methods could include payment plans and donations from parent-teacher organizations, as we witnessed with our case districts. It may be beneficial to parents if the fee collection event is conducted simultaneously with device deployment parent nights.

6.2.6 Repair and Replacement

District personnel spoke about the challenges they face with maintaining devices. Students and teachers accidentally break devices and devices malfunction. District leaders have developed both policies and procedures to address device repair and replacement. They address both accidental and intentional damage. The policies and procedures provided direction regarding the steps needed to repair or replace the device. District leaders communicated these policies and procedures in a variety of ways, through official school board policy, forms used when receiving devices and paying fees, and through guide-

lines posted on district websites.

In an effort to reduce repair cost and lengthy repair times, the literature references district technology personnel that train students to work alongside technicians to repair student and teacher devices. Districts One and Three personnel spoke extensively about their use of individual school help desks staffed, in part, by students.

6.2.6.1 Recommendations

We recommend that these policies or procedures be clearly communicated with parents and staff. District leaders may want to share them at the same time that fees are collected at a deployment night with parents. By including the procedures as official policy would help ensure that repairs and damage claims are consistently handled between all schools.

District staff can greatly reduce the repair cost and time by training their own students and teachers with an affinity for devices to provide support through the district's help desk system. District leaders also need to specify in their policies about how they classify and address issues with breakage and both accidental and intentional damage to devices.

6.3 Professional Development

Both teachers and administrators across our case districts participated in professional development activities in connection with their ubiquitous computing programs.

6.3.1 Two Types of Training

These activities targeted two components of teaching with computers: gaining familiarity with new technology and methodologies for teaching with technology or "technology integration." We believe it is important to consider that in one case, the new technology provided to teachers was the first time they were issued technology. In others, teachers had previous experience using technology they could take home, but it was a different type of device (iPad or Chromebook). In each case, the one-to-one initiative involved the deployment of devices to staff that required training on how to use a new device. In all but one case, initial professional development efforts primarily focused on device usage. In District Four, initial professional development almost exclusively focused on technology integration. Among the case districts, leaders provided professional development highlighting a variety of approaches.

6.3.1.1 Recommendations

District leaders need to plan for adequate time to prepare training resources before devices are deployed. Because each district's deployment is unique, research must be conducted to understand staff and student needs for professional development. Whether or not the training for changing pedagogy is done right from the start, district leaders must address the changes they wish to see with instruction as part of their professional development planning and execution.

6.3.2 Vendor Training

Many districts elected to use training services offered by the technology vendor(s). Comments from technology leaders and technology coaches across our focus group interviews indicated that the use of external trainers did not always fully address their needs. District One uses vendor-supplied training consultants that help with the instructional side of their deployment. A leader from District One named one consultant in particular for his high level of expertise, and noted he did not work for the laptop vendor, but that the laptop vendor outsourced high-quality professional development. Both District One and District Three received their vendor training as part of a multi-year lease agreement. The case districts we studied used vendor expertise on both technical and instructional issues. Some case districts used vendor trainers with "train the trainer" models to provide expertise for technology coaches or other trainers within a district, so that the new information could be custom-

tailored to the needs of teachers in their schools.

6.3.2.1 Recommendations

Vendors may be able to offer training with expertise in areas the district does not already possess. District leaders can also request vendor training that is specific to their needs. A less expensive option for district leaders is to use vendor-provided trainers to train staff that will later coach administrators, teachers, or technology staff with new expertise customized to the district staff's needs.

6.3.3 Summer Training

All of our case districts used break time in the summer to conduct training for their ubiquitous computing initiatives. In many cases, this time was already established for professional development for previous district initiatives. Leaders from District One recounted the high participation rates from their initial training, at least in part, because of the teachers' incentive of paid time. Districts Two, Three and Four leaders used a portion of the summer training time to cover the familiarity phase of using the devices.

6.3.3.1 Recommendations

Using a teacher's summer vacation to offer training was not a novel idea across our case districts. However, district leaders may consider budgeting for professional development to include paid time for teacher participation. If district leaders are just beginning their one-to-one initiative with new devices unfamiliar to the staff, they should allocate some time to train teachers on the basic use of the device.

6.3.4 Differentiated Training

Personnel from many case districts spoke of the importance of differentiating or personalizing training for the needs of individual teachers. From the literature, we identified several continua for describing where a teacher may "fit" in relationship to their disposition and abilities with using technology as a pedagogical tool (LoTI, 2011; Philipp, Flores, Sowder, & Schappelle 1994; Puentedura, 2013; Rogers, 2003). District One used post-training surveys to assess the needs of teachers so they could be placed in subsequent training activities that matched both their needs and aptitudes. District Three's technology coaches offered training sessions in both short (snack-sized) and long (meal-sized) formats, many times with themes or workshop titles that was enticing for teachers, e.g. "Deck the Halls with Apps of Holly." The technology team in District Four led sessions in consultation with the pilot school principal with each grade level of teachers, presumably offering training in a small group with allowances for individually answering questions and concerns. District Five described their initial training as "generic," providing the same training to all teachers at the start of their program. After six months into their deployment, however, training is now designed around specific requests from teachers.

6.3.4.1 Recommendations

The "quality" criterion with professional development calls for training to be relevant. The districts across our case studies each utilized different methods for trying to personalize training by offering different modalities (after school workshops or online tutorials), different lengths of time (snacks or meals), and specificity with topics based on a teacher's reported needs. We recommend districts offer differentiated training opportunities for teachers using a variety of modalities.

6.3.5 Online Training

Many districts provided professional development support online for independent learning by staff, and in some cases, students. The support came in the form of self-guided courses with assessments, lists of links and videos for learning more, and customized video tutorials created by technology coaches.

6.3.5.1 Recommendations

Creating your own content or listing links to other available content online helps provide teachers anytime, anywhere support. In addition to free materials, some district leaders may elect to use purchased online content to increase the quality and breadth of their online training library.

6.3.6 Coaching

Throughout our research, it became clear that the role of the technology coach was indispensable in supporting the success of a ubiquitous computing initiative. Coaches offered support in a number of ways, including co-teaching and modeling using technology in the classroom, by offering after-school or during-school workshops, offering answers to questions from teachers via email or instant messaging services, and through the planning of lessons. Coaches across the case districts often were former teachers or former staff development experts. Staff we interviewed from District One was adamant that this role was developed to provide instructional support, and not technical support for the initiative. Both District One and District Four leaders hired new coaches to support their one-to-one program.

6.3.6.1 Recommendations

Technology coaches need to be employed and dispatched to schools to provide formal training and support with teaching. We recommend that technology coaches be available daily to support teachers. The three technology coaches in District Five told us they are in their district's schools "every day." The technology plan for District Two called for a coach-to-student ratio of 1:1000 across their schools. Providing an adequate number of coaches to support learning and teaching with technology is a financial obligation district leaders must provide for in their planning.

6.4 Challenges

During our review of the data collected for this study, we observed challenges by district staff in obtaining funding, garnering support from stakeholders, changing classroom paradigm, and updating infrastructure.

6.4.1 Funding

Districts that were not able to fund the one-to-one initiative out of their operational budget had to look for other ways to fund the program such as with grants, textbook monies, and stimulus funding to purchase or lease their devices. Some districts found the option of leasing the devices beneficial because it allowed them the opportunity to acquire more technology up front instead of having to budget over time.

Some district leaders also spoke about the importance of considering not just the cost of the devices but other expenses which should be included in the total cost of the program. Sometimes, these additional costs included infrastructure upgrades, replacement devices, and software. In addition, ongoing expenses such as professional development, repairs, and apps were sometimes not included in the total cost. A former technology director from District One spoke of how they did not include the cost of stolen or lost chargers in their total cost for the program. He stated the district spent several thousands of dollars to replace the chargers.

Some district leaders faced a challenge of securing funding to scale up the program. In District Three, we learned that the superintendent was seeking additional funding to maintain the current program and to expand the devices to additional grade levels. She spoke of securing a grant through her state to cover the funding for the program for an additional four years.

6.4.1.1 Recommendations

We recommend that district leaders look outside of their op-

erational budget if they cannot accommodate the cost of the initiative. Some examples of funding sources include textbook funds, grants, or donations. District leaders could also consider leasing and acquire all of the devices at once instead of having to budget and purchase over a period of time. District leaders should consider the total cost of the one-to-one initiative when planning for the program budget. If district leaders are looking to scale up the program in subsequent years, they should make allowances for this cost in future financial plans.

6.4.2 Garnering Support

Continually communicating the purpose and vision of the initiative to all stakeholders to garner their support can be a challenge. Leaders from District One faced media scrutiny a few years into the deployment. As a method of combating the negative portrayal the implementation was receiving, district leaders showcased positive student use of laptops in a local cable television network. In District Four, as a response of school board members questioning the financial viability of the program, the technology team shared student-created projects on their iPads to school board members. District Five engaged teachers in conversation about the creative ways of using devices in the classroom through a website. Technology coaches uploaded tutorials and teachers gave personal feedback on how the lessons went when using the devices with students. District One collected examples of lessons incorporating twenty-first century skills and compiled them on a website for other teachers and administrators to access.

6.4.2.1 Recommendations

Leaders should develop multiple ways to communicate the purpose of their one-to-one programs. This communication needs to be consistent and presented to all stakeholders including local media outlets. District personnel should provide examples of the types of instruction that is occurring with the devices. In addition, teachers should be encouraged to share their technology-based lessons with other teachers across the district. We liked the examples presented from Districts One and Five where exemplars of good instruction not only provided resource support for the district's teachers, but also demonstrated the types of high quality instruction that was taking place within those districts.

6.4.3 Changing Teaching Paradigms

The literature references that the introduction of new technology will not, in itself, change classroom pedagogy. Despite the fact that some districts in our study already had mobile computing devices on carts available in limited numbers to students before the one-to-one initiative, they had not yet been able to significantly change pedagogy. District leaders shared the reality that changing pedagogy was a slow process. District Three's superintendent said she expected the pedagogical change to take at least five years. District leaders across all cases spoke of the patience required to see significant change. One former principal shared his leadership advice for supporting the change: "Apply sustained, quiet pressure."

District Four leaders focused their professional development at the start of their initiative on pedagogical change, in concert with use of technology. District Five waited for teacher comfort to increase with the new technology before delivering training on project-based learning, in line with the "comfort first" and "pedagogy second" approach used in our other three case districts.

Both Districts One and Five utilized online blogs for sharing lesson ideas and resources to further their teachers' learning. Leaders in other districts helped differentiate their training methods by posting resources online recommended by their technology coaches, by changing the length and format of training sessions after school, and by designing training sessions based on articulated teacher needs.

6.4.3.1 Recommendations

District leaders should make sure there is a professional development plan in place to address changing teaching paradigms. The TPACK model recommends that professional development focus on three areas of knowledge: pedagogy, content, and technology. We liked District One's catalog of twenty-first century skill-embedded lessons by their teachers. District leaders should also be cognizant of a teacher's comfort level of using technology for instruction and design subsequent training programs based on their needs. District leaders should also understand that this change will take some time but to continue providing differentiated training for teachers until this goal is reached.

6.4.4 Infrastructure

Many district personnel across our study had to modify their current infrastructure prior to starting their one-to-one initiatives. Some districts already had wifi capabilities and had completed pilot programs to test the functionality of the network and servers on their current system. However, personnel in some districts realized they had to add additional resources to support the program even after the pilots. A District One technology coach spoke of underestimating the effects of so many teachers and students connecting to the school's network oversaturating their wireless access points. Districts One and Four personnel secured the expertise of outside experts to prepare for the expected impact the one-to-one implementation would have on bandwidth and wireless saturation. District Three technology staff deploying iPads sought support from both Apple and peer districts in their struggles with iPad deployments using mobile device management tools and syncing carts before Apple's latest upgrades.

6.4.4.1 Recommendations

District leaders should carefully analyze their current infrastructure during the planning stages of a one-to-one program. This should include reviewing the current network bandwidth and wireless capabilities at all school buildings. Technology personnel may solicit input from outside experts, including vendors, to assess the current infrastructure of the district. After the aspects of the district's infrastructure have been updated, a pilot program should be conducted before deploying devices to all students.

6.5 Conclusion

Combined with our logic model depicting the stages of implementation for a ubiquitous computing program, we trust that our recommendations, drawn from both the literature and our analysis of qualitative data collected from five case districts, can help a school district approach a new one-to-one initiative with confidence and optimism.

6.5.1 Limitations of this Evaluation

The districts in our study were chosen based on their diversity. The members of our team connected with district contacts that were familiar through our own professional relationships or through connections with our capstone committee members. Despite the fact that all the interview participants were involved in the initiatives, the district contacts selected the interview participants and this resulted in incongruity of focus groups across the case districts. Some potential participants could not be interviewed due to conflicting schedules even though the district contact had invited them.

The interview process also offered some limitations. Our interviews took place in individual and focus group settings. Interviews were conducted in one sitting with follow-up questions asked over email. In some instances, not all participants could stay the entire length of time of the focus group and the dynamics of the group changed slightly as people came and left. Follow-up questions were sent through email but not all

responses came back before the end of the study. Also, the data obtained in both individual and focus group interviews were self-reported and partially verified by other participants in the interviews. However, most of the data were individual reflections of perceived experiences, which could not be substantiated.

Follow-up questions sent to District Two by email were not answered directly by interview participants, although we did receive requested feedback from interview participants after submitting the district profile for review. Feedback on the profile sent to District Five was not provided. The lack of communication from District Five after our interview prevented us, likewise, from getting clarification related to the details of their funding choice.

Finally, the documents provided by the districts varied and not all district contacts granted us copies of the requested documents. Although we have a significant number of artifacts, we were limited to analyzing only what had been provided or found by a member of the research team on district websites.

6.5.2 Recommendations for Future Evaluations

Future evaluations could help districts determine what the best course of action is for planning a ubiquitous computing initiative. Our recommendations include conducting classroom observations, interviewing students and teachers, and modifying the interview setting. These data collection efforts were not undertaken in this study due to the allotted time provided for the research.

In our study, the team conducted some informal observations and spoke to teachers and students in three districts. These observations were not included in the data because observation was not part of the study design nor were we invited to visit the schools in all districts. The small number of observations we did conduct influenced our lens for analyzing the interview data from that district and we realize the importance of matching up interviewee beliefs and actual practice in schools.

In addition, we recommend researchers interview teachers and students and gather their perspectives about challenges and successes related to the initiative. In our study, some district leaders were able to express some concerns made by the teachers in their district, but adding the student and teacher viewpoints would have resulted in a more comprehensive data collection.

Finally, interviews should be conducted over multiple settings. Based on our own interview experiences, we would recommend a small focus group of like-status staff where the interviewers ask three or four over-arching questions. Then one on one interviews could take place to gather individual perceptions. We believe this double interview approach would allow the interviewer to gather group dynamic data, as well as allow for multiple viewpoints on each question without one strong person influencing the responses.

The findings of our study are not revolutionary in the literature of one-to-one initiatives available. However, the case studies of the districts we have studied paint five individual, realistic pictures of how district leaders have been able to bring technology into students' hands and change classroom pedagogy. Our study can help other districts contemplating the leap into ubiquitous computing understand that different districts with different needs and student populations can all reach similar goal of using technology as the tool to improve instruction.

References & Appendices

Photo courtesy Flickr user erix

Chapter 7

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Appendix A

VIRGINIA COMMONWEALTH UNIVERSITY

1:1 COMPUTING STUDY

Introduction
VCU's School of Education has an Ed.D in Education Leadership program that asks students to finish their program with original research in a capstone program. Our four-person team is studying 1:1 computing initiatives. We're interested in interviewing administrators in districts that have already had experience with 1:1 computing. In short, this is what we're after, and would invite your participation:

- What were the successes of your program?
- What might other districts find challenging?
- How do you support the program with professional development?
- What policies and procedures do you use to support the program?

We're interested in interviewing administrators who manage and plan for your initiative. Our period of data gathering will be September, 2013–January, 2014. Details about our research program follow.

Purpose

We are conducting a multiple-site case study on the implementation of 1:1 computing in schools, and where applicable, districts. We are interested in learning about the goals, the challenges and successes experienced in these initiatives, the policies used to support the initiative, and steps taken to provide quality professional development.

Data collected through interviews with key personnel in these schools or districts will be provided in a write up and analysis to participants. The identity of schools or districts can be anonymized without an impact on our study. The purpose for our study is to paint a picture of what implementing 1:1 initiatives look like from across the perspective of different environments and through using different devices (laptops, mobile devices).

Data collection will be carried out through group or one-on-one interviews with key personnel responsible for the implementation of instruction with technology. Personnel might include technology directors, directors of instruction, directors of professional development, directors of instructional technology, instructional technology resource teachers or mentors, or comparable positions, and building principals or assistant principals.

We will also collect documents so we may analyze these policies, forms, and procedures that relate or support the 1:1 computing program.

The scope of our study will not collect data from teachers or from students. Our data collection will not include classroom observations or discussions with parents. Our study will only concern administrators and personnel directly involved in the program and professional development efforts.

Research Method

We will apply a multi-case approach of our topic (one-to-one initiative deployments) from the perspectives of each locality (including specific features of each implementation, based on the population(s) served, or the types of devices deployed).
Data will be collected in order to develop a story of what is happening in each location. We will then analyze what has happened and compare the commonalities and differences among the cases.

The two methods used will be interviews of stakeholders involved in the execution of programs and the analysis of documents gathered used to support programs.

Interviews may consist of face to face, phone, or VOIP-based (e.g. Skype) sessions . We will send interview questions ahead of the agreed upon interview session times. This will allow the participants time to consider the questions in advance of the formal, recorded interviews.

If the opportunity arises for us to conduct informal observations of the technology integration in action, we will do so with the purpose to better understand the flavor of implementation at the school or district, with permission and approval of the participants in advance. Any observations will not involve data collection, but will be used for our own understanding as researchers.

We will also ask for a key number of documents. Documents may include: acceptable use policies, communication with stakeholders (students/teachers/parents), such as letters, forms, rules, disciplinary decisions/regulations, insurance agreements, and copies of training materials from meetings with teachers, students and/or parents. Professional development plans/documentation delivered to teachers, reports of end of year number of trainings and how many teachers attended may also be collected and analyzed, if available.

How You Can Help

If you are willing to assist us with this study during the 2013-14 SY, please reply to this message and we will follow up with you soon to make arrangements for a visit to your location to conduct the interview portion of our data collection. We thank you in advance for considering to participate in this study, and we hope that the data collection we perform will be helpful to you in your continued implementation of one-to-one computing.

Appendix B

Office of Research
Office of Research Subjects Protection
BioTechnology Research Park
800 East Leigh Street, Suite 3000
P.O. Box 980568
Richmond, Virginia 23298-0568

(804) 828-0868
Fax: (804) 827-1448

TO: Charol Shakeshaft, PhD
CC: Derrick Deloatch, John Hendron, Eun Kim, Shawnya Tolliver
FROM: VCU IRB Panel B
RE: IRB HM20000320 Blended Learning Scale-Up Case Study Analysis of 1:1

On 1/16/2014, the referenced research study was ***approved*** by expedited review according to 45 CFR 46.110, Categories 6 and 7, by VCU IRB Panel B.

- The information found in the electronic version of this study's smart form and uploaded documents now represents the currently approved study, documents, informed consent process, and HIPAA pathway (if applicable). You may access this information by clicking the Study Number above.

This approval expires on 12/31/2014. Federal Regulations/VCU Policy and Procedures require continuing review prior to continuation of approval past that date. Continuing Review notices will be sent to you prior to the scheduled review.

If you have any questions, please contact the Office of Research Subjects Protection (ORSP) or the IRB reviewer(s) assigned to this study.

The reviewer(s) assigned to your study will be listed in the History tab and on the study workspace. Click on their name to see their contact information.

Attachment – Conditions of Approval

Conditions of Approval:

In order to comply with federal regulations, industry standards, and the terms of this approval, the investigator must (as applicable):

1. Conduct the research as described in and required by the Protocol.
2. Obtain informed consent from all subjects without coercion or undue influence, and provide the potential subject sufficient opportunity to consider whether or not to participate (unless Waiver of Consent is specifically approved or research is exempt).

3. Document informed consent using only the most recently dated consent form bearing the VCU IRB "APPROVED" stamp (unless Waiver of Consent is specifically approved).
4. Provide non-English speaking patients with a translation of the approved Consent Form in the research participant's first language. The Panel must approve the translated version.
5. Obtain prior approval from VCU IRB before implementing any changes whatsoever in the approved protocol or consent form, unless such changes are necessary to protect the safety of human research participants (e.g., permanent/temporary change of PI, addition of performance/collaborative sites, request to include newly incarcerated participants or participants that are wards of the state, addition/deletion of participant groups, etc.). Any departure from these approved documents must be reported to the VCU IRB immediately as an Unanticipated Problem (see #7).
6. Monitor all problems (anticipated and unanticipated) associated with risk to research participants or others.
7. Report Unanticipated Problems (UPs), including protocol deviations, following the VCU IRB requirements and timelines detailed in VCU IRB WPP VIII-7:
8. Obtain prior approval from the VCU IRB before use of any advertisement or other material for recruitment of research participants.
9. Promptly report and/or respond to all inquiries by the VCU IRB concerning the conduct of the approved research when so requested.
10. All protocols that administer acute medical treatment to human research participants must have an emergency preparedness plan. Please refer to VCU guidance on http:/www.research.vcu.edu/irb/guidance.htm.
11. The VCU IRBs operate under the regulatory authorities as described within:
    a. U.S. Department of Health and Human Services Title 45 CFR 46, Subparts A, B, C, and D (for all research, regardless of source of funding) and related guidance documents.
    b. U.S. Food and Drug Administration Chapter I of Title 21 CFR 50 and 56 (for FDA regulated research only) and related guidance documents.
    c. Commonwealth of Virginia Code of Virginia 32.1 Chapter 5.1 Human Research (for all research).

Appendix C

VIRGINIA COMMONWEALTH UNIVERSITY

September 14, 2013

Person's Name
Person's Institution
Address
City, State, Zip

Memorandum of Understanding - VCU Capstone Project

Thank you for agreeing to assist us with our multiple-site case study on the implementation of 1:1 computing in schools, and districts. We are interested in learning about the goals of your initiative, the challenges and successes experienced in these initiatives, the policies used to support the initiative, and steps taken to provide quality professional development.

The audience for our project is schools and districts that may be considering starting 1:1 computing programs. We believe this research will help those schools and districts make understand the implementation process.

Data collection will begin in September and be completed by December, 2013. While we want to make your involvement as easy as we can, we will need your help in identifying documents, communicating your agreement to cooperate in the research to targeted audiences, and identifying spaces in your district where we might conduct interviews and focus groups. The following are the activities in which we will engage to make sure our case study is complete.

1. Identify and share published and unpublished documents used as part of the 1:1 computing program implementation, including (but not limited to, in case you have other important documents):
    a. Acceptable Use Policy,
    b. official communications with parents, students, and teachers (letters, rules, insurance agreements, training materials, etc.),
    c. professional development plans or documentation, if it exists (i.e., reports about how many sessions were offered, and how many staff participated);

2. Facilitate, as necessary, interview and focus group cooperation and location. We will be

conducting group or individual interviews (face to face or via electronic means such as Skype or Google Hangout) with key school or district stakeholders, including:

a. director of technology,
b. director of instruction,
c. director of professional development,
d. principals or assistant principals,
e. instructional technology resource teachers,
f. director of instructional technology,
g. or any other key stakeholders with comparable titles or roles within the program.

These interviews may be followed by clarification queries, most often through email.

Our capstone team, with the advisement of VCU School of Education professor Dr. Charol Shakeshaft, will deliver to you a report summarizing our research at your school or district. We believe this will help you by having an uninterested, third party examine your 1:1 computing program. The report will be delivered by April 1, 2014 and include:

1. A summary of the analysis of the documents received,
2. A summary with themes and discussion of the transcribed interviews.

Participant districts and individuals will be identified in the case, unless you would like us to provide pseudonyms.

We will not collect data from teachers or from students. Our data collection will not include classroom observations or discussions with parents. Our study is focused on the experiences of administrators and personnel directly involved in the implementation and administration of the program.

Thank you in advance for your cooperation with our study.

Charol Shakeshaft, Ph.D.,
Capstone Chair - VCU School of Education

_____ district/school agrees to the terms of this research study.

_____ _____

School or District Research Officer or Superintendent

Date

Appendix D

Virginia Commonwealth University
Ed.D. in Educational Leadership Capstone Program

Scaling Up Blended Learning:
Case Study Analyses of One-to-One Computing Initiatives

Shawnya Tolliver

Angie Kim

Derrick Deloatch

John Hendron

VCU
VIRGINIA COMMONWEALTH UNIVERSITY

www.soe.vcu.edu

Our multiple case study will look at ubiquitous computing environments across districts with a focus on challenges and successes with implementation. Our research is the final component of a doctoral program in educational leadership. We bring a diverse amount of practical experience in education towards this endeavor.

Meet the Team

Dr. Charol Shakeshaft, Director

Charol Shakeshaft is professor in the Department of Education Leadership at Virginia Commonwealth University in Richmond, Virginia. Charol is the author of three books and over 200 referred articles and papers, many of which have received national and state awards. Her research focuses on three strands of inquiry: Women in leadership; educator sexual misconduct; and learning outcomes with technology delivery. Dr. Shakeshaft is the recipient of a $5.2 million grant to develop state of the art principal preparation to include the first immersive, interactive and web-enabled computer simulation for school administrators.

Derrick Deloatch, doctoral candidate

Derrick has devoted his life to educating others. He began his career at Brookland Middle School in Henrico County as an 8th grade science teacher. After spending 9 years in the classroom, he decided to enter administration. He received his first administrative appointment as an assistant principal at Mills E. Godwin High School in 2006. Derrick returned to Brookland Middle School in 2011 as the principal. He is looking forward to utilizing the knowledge gained through the Ed.D program at VCU to enhance his leadership skills. More information about Derrick's development as a leader can be found through visiting his online portfolio at *derrickdeloatch.wordpress.com/*.

John Hendron, doctoral candidate

John is a passionate learner. As supervisor of instructional technology for Goochland County Public Schools, he works as an instructional leader, developing the division's technology plan, planning and delivering technology integration workshops, and adds value to his job through his skills in graphic design and photography. John has served on the board of the Virginia Society for Technology in Education, through which he earned the *Making IT Happen Award*, an international honor, in December, 2012. You can learn more about John's educational journey in the Ed.D. program through VCU at *johnghendron.wordpress.com*.

Angie J. Kim, doctoral candidate

Angie is a reflective learner. She began reflecting as a teacher in a second grade classroom and then taught a year in fourth grade. An opportunity opened up to become an administrator as the Resource Teacher at an elementary school in Henrico. The following year, she became the Assistant Principal and held that position for three years. Angie is looking forward to taking all of the learning from the past two years of the Educational Leadership Program and putting it into practice for the Mobile Computing Capstone. You can see examples of Angie's growth and learning on her portfolio site: *angiejkim.wordpress.com*.

Shawnya Tolliver, doctoral candidate

Shawnya is an innovative educator who has spent the last 21 years inspiring elementary students. Her career began with 11 years of engaging kindergarten and second grade students in learning with two years in Burlington, North Carolina and nine years at Arthur Ashe Elementary with Henrico County Public Schools. Shawnya has worked at Highland Springs Elementary School in Henrico County for the past ten years. She began as the resource teacher for the first three years. She then moved into the role of assistant principal for five years and is now is principal, since 2011. As Shawnya begins her third year in VCU's Ed.D. Program she eagerly looks forward to applying the knowledge she has gained to her future educational endeavors. More information about Shawnya's journey can be found at *shawnyatolliver.wordpress.com/*

June, 2013 - May, 2014

Appendix E

VIRGINIA COMMONWEALTH UNIVERSITY

September 30, 2013

To the participants of <school district>,

Thank you for your willingness to be interviewed for our doctoral study on 1:1 computing in schools. We're hoping that the insights you share with us will guide and inform other schools/ districts that seek to implement a 1:1 computing initiative.

Below are questions we will be asking during the interview. Please take a moment to read the question over before the interview.

Thank you in advance for the opportunity to hear your perspectives and gather your insights about the one-to-one computing initiative in your district/school. We look forward to seeing you in the interview.

Interview Topics

- Planning steps in rollout
- Policies to support initiative
- Professional development activities, plans, and programs
- Challenges at each step of the rollout
- Successes in implementation
- Definition of success
- Technology, instructional, learning, and implementation goals
- Recommendations for other districts

Interview Questions

(Additional follow up questions may be asked in the interview or through email after the interview based on the answers.)

1. As we seek to learn more about your school or district, how would you describe your schools (district) to a family who was considering moving in the area?
2. For the record, at what schools and grade levels have your currently deployed your technology?
3. With regards to your computing initiative, what steps did you go through to plan for your rollout?
4. What new policies did you implement to support the initiative?
5. What were some of the professional development activities and programs created to support the administrators and teachers prior and during the implementation of the devices?
6. What challenges have you faced?
7. What criteria are you using to determine the success of the 1:1 program?
8. What have you been most successful with in your implementation?
9. What were the goals for your 1:1 program?
10. What would you recommend for another district starting a 1:1 program?

If you have any questions or concerns about this process, feel free to contact us ahead of our scheduled interview time on <date and time>. Before our interview session begins, you will have the opportunity to review and sign a consent form. Thank you again for agreeing to participate in this research study.

Angie Kim, VCU Doctoral Candidate contact for <district>

Additional VCU contacts:

Dr. Charol Shakeshaft, Professor,
cshakeshaft@vcu.edu, 804-828-1940 or 804-752-2413
Derrick Deloatch, Doctoral Candidate,
ddeloatch@mymail.vcu.edu, 804-539-1140;
John Hendron, Doctoral Candidate,
hendronjg@mymail.vcu.edu, 804-405-0487;
Angie Kim, Doctoral Candidate,
ejkim@mymail.vcu.edu, 804-304-6173;
Shawnya Tolliver, Doctoral Candidate,
jonesss3@mymail.vcu.edu, 804-502-3025.

Appendix F

VIRGINIA COMMONWEALTH UNIVERSITY

Date

To the participants of _____ Schools,

Thank you for your willingness to be interviewed for our doctoral study on 1:1 computing in schools. We're hoping that the insights you share with us will guide and inform other schools/ districts that seek to implement a 1:1 computing initiative.

Below are questions we will be asking during the interview. Please take a moment to read the question over before the interview.

Thank you in advance for the opportunity to hear your perspectives and gather your insights about the one-to-one computing initiative in your district/school. We look forward to seeing you in the interview.

Interview Topics

- Planning steps in rollout
- Policies to support initiative
- Professional development activities, plans, and programs
- Challenges at each step of the rollout
- Successes in implementation
- Definition of success
- Technology, instructional, learning, and implementation goals
- Recommendations for other districts

Interview Questions

(Additional follow up questions may be asked in the interview or through email after the interview based on the answers.)

1. Could you describe your district before the 1:1 implementation?
2. For the record, at what schools and grade levels have you currently deployed your technology?
3. What were the major milestones in the planning process?
4. What were the long-term and short-term goals for your 1:1 program?
5. What were some of the professional development activities and programs created to support the administrators and teachers prior and during the implementation of the devices?
6. What new policies did you implement to support the initiative?
7. What challenges have you faced?
8. What criteria are you using to determine the success of the 1:1 program?
9. What have you been most successful with in your implementation?
10. If you could do it all over again, what would you do differently?

If you have any questions or concerns about this process, feel free to contact us ahead of our scheduled interview time on _____. Before our interview session begins, you will have the opportunity to review and sign a consent form. Thank you again for agreeing to participate in this research study.

Dr. Charol Shakeshaft, Professor,
cshakeshaft@vcu.edu, 804-828-1940 or 804-752-2413
Derrick Deloatch, Doctoral Candidate,
ddeloatch@mymail.vcu.edu, 804-539-1140;
John Hendron, Doctoral Candidate,
hendronjg@mymail.vcu.edu, 804-405-0487;
Angie Kim, Doctoral Candidate,
ejkim@mymail.vcu.edu, 804-304-6173;
Shawnya Tolliver, Doctoral Candidate,
jonesss3@mymail.vcu.edu, 804-502-3025.

Appendix G

This Box for IRB Office Use Only –
Do Not Delete or Revise
Template Rev Date: 5-15-12

Appendix C: Consent Form for Interviews

RESEARCH SUBJECT INFORMATION AND CONSENT FORM

TITLE: BLENDED LEARNING SCALE-UP: CASE STUDY ANALYSIS OF 1:1 COMPUTING INITIATIVES

VCU IRB NO.: HM20000320

SPONSOR: none

If any information contained in this consent form is not clear, please ask the study staff to explain any information that you do not fully understand. You may take home an unsigned copy of this consent form to think about or discuss with family or friends before making your decision.

PURPOSE OF THE STUDY
The purpose of the study is to explore the planning and implementation of one-to-one computing in schools. In a one-to-one or ubiquitous environment, schools provide a computing device to each student and in most cases, the devices are allowed to go home. Our focus will include how school and district stakeholders conduct professional development with teachers, how administrators communicate with parents and other stakeholders, what policies and procedures support the one-to-one computing, and what stakeholders schools cite as challenges and successes with implementing one-to-one computing initiatives.

You were selected to participate in this study because of your direct involvement with the implementation of the one-to-one program in your district.

DESCRIPTION OF THE STUDY AND YOUR INVOLVEMENT
If you decide to be in this research study, you will be asked to sign this consent form. In this study, you will be asked to participate in an interview or focus group to provide feedback regarding your district's one-to-one implementation. The questions will focus on the following seven themes: 1) planning steps in rollout, 2) policies to support the initiative, 3) professional development activities, plans, and programs, 4) challenges at each step of the rollout, 5) successes in implementation, 6) definition of success, 7) technology, instructional, learning, and implementation goals, 8) recommendations for other districts.

The meetings will be digitally recorded so we have accurate appraisal of the interview, but no names will be recorded. Based on the findings during the course of this study, you may be asked to provide further clarification through a follow-up interview, email, or phone call.

By signing this consent form, you acknowledge that any optional observation offered to

the research team in a school setting with students or teachers cannot and will not be used for the purpose of this study. Observations will not involve any data collection.

RISKS AND DISCOMFORTS
The risk and discomforts are minimal in this study. Participants can decline to participate or answer certain questions if they choose at any time during the interview.

BENEFITS TO YOU AND OTHERS
You may not get any direct benefit from this study, but the information we learn from people in this study may help others design better programs for schools involved in ubiquitous computing programs.

COSTS
There is no monetary cost to participating in this study. Interviews will take about an hour and additional time may be requested for follow up questions either through email, phone call, or a face-to-face interview time.

CONFIDENTIALITY
Potentially identifiable information about you will consist of interview notes and recordings, and names as they may appear in documents submitted for analysis. The identities of the participants will be removed from
summaries and analysis. Initials will be used in interview transcripts. All personal identifying information will be kept in password protected files and these files will be deleted at the conclusion of our study Other records, including research notes maintained by the investigators, will be kept in password-protected files and will be destroyed at the end of the study Documents collected from schools, such as acceptable use policies and technology plans, will be kept indefinitely. Access to all data will be limited to study personnel. The safety of electronic documents is monitored by Virginia Commonwealth University through protocols in conjunction with Google Apps for Education. It operates over an encrypted network connection with a rigorous password protection by the university.

What we find from this study may be presented at meetings or published in papers, but your name will not ever be used in these presentations or papers.

The name of your school or district (division) may be used as part of this study. Your district representative may choose to keep the name of your school or district confidential after reviewing the summary of our data collection presented in January, 2014.

The group sessions will be audio recorded, but no names will be recorded. At the beginning of the session, all members will be asked to use initials only so that no names are recorded. The recording and the notes will be stored in a password protected electronic files. After the information from the recording is typed up, the recording will be destroyed.

VOLUNTARY PARTICIPATION AND WITHDRAWAL
You do not have to participate in this study. If you choose to participate, you may stop at any time without any penalty. You may also choose not to answer particular questions that are asked in the study.

Your participation in this study may be stopped at any time by the study staff or the sponsor without your consent. The reasons might include:

- the study staff thinks it necessary for your health or safety;
- you have not followed study instructions;
- the sponsor has stopped the study; or
- administrative reasons require your withdrawal.

QUESTIONS
If you have any questions, complaints, or concerns about your participation in this research, contact:

Dr. Charol Shakeshaft, Professor,
cshakeshaft@vcu.edu, 804-828-1940 or 804-752-2413
and/or
Derrick Deloatch, Doctoral Candidate,
ddeloatch@mymail.vcu.edu, 804-539-1140;
John Hendron, Doctoral Candidate,
hendronjg@mymail.vcu.edu, 804-405-0487;
Angie Kim, Doctoral Candidate,
ejkim@mymail.vcu.edu, 804-304-6173;
Shawnya Tolliver, Doctoral Candidate,
jonesss3@mymail.vcu.edu, 804-502-3025.

The researcher/study staffs named above are the best persons to call for questions about your participation in this study.

If you have any general questions about your rights as a participant in this or any other research, you may contact:

Office of Research
Virginia Commonwealth University
800 East Leigh Street, Suite 3000
P.O. Box 980568
Richmond, VA 23298
Telephone: (804) 827-2157

Contact this number for general questions, concerns or complaints about research. You may also call this number if you cannot reach the research team or if you wish to talk with someone else. General information about participation in research studies can also be found at http://www.research.vcu.edu/irb/volunteers.htm.

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Template Rev Date: 5-15-12

CONSENT

I have been given the chance to read this consent form. I understand the information about this study. Questions that I wanted to ask about the study have been answered. My signature says that I am willing to participate in this study. I will receive a copy of the consent form once I have agreed to participate.

_____		_____
Participant name printed	Participant signature	Date

_____	_____
Name of Person Conducting Informed Consent Discussion / Witness [3] (Printed)	Date

_____	_____
Signature of Person Conducting Informed Consent Discussion / Witness	Date

_____	_____
Principal Investigator Signature (if different from above)	Date

Appendix H

<District>
Document Checklist

- ☐ Acceptable Use Policy (for both staff and students, if they are separate documents)
- ☐ Technology plan
- ☐ Professional development plans
- ☐ Handouts/website tutorials shared at professional development
- ☐ Any brochures regarding the 1:1 program shared with the community
- ☐ Parent Communication Letter/Flyer for informational session
- ☐ Principal letter/communication with parents regarding 1:1
- ☐ Permission forms parents signed related to technology (bringing home device, setting up email access, etc.)
- ☐ Policies/procedures related to discipline
- ☐ Rules or guidelines created for students using technology
- ☐ Lessons or training for students based around Digital Citizenship or Internet Safety
- ☐ Purchase agreement with vendor

Please submit these documents no later than <Date> to <team member email>

Thank you for your willingness to help us with this study and ultimately, help other educators interested in launching ubiquitous computing initiatives!

Appendix I

Interview Procedure and Questions to Read During Interview

Hello, I'm _____, (second person), (third person), & (fourth person). We are fellow educators and doctoral students in Educational Leadership at VCU. Thank you for graciously agreeing to allow us to gather your perspectives about practices related to the one-to-one computing initiative in your district/school.

We're hoping that the insights you share with us will guide and inform other schools/ districts that seek to implement a one-to-one computing initiative.

We are audio recording this session, but know that we will remove any personal identifiers when we transcribe the recording. In other words, we promise confidentiality and your anonymity as we work with the data we are gathering. (However, please be aware that you are in a group setting, and we cannot guarantee that everyone else in this room will abide by these same guidelines.) If, at any time, you have second-thoughts about what you have said during this interview, you may ask to have your comments removed from the transcript.

We hold ourselves to high professional standards and plan to use this experience to provide fellow educators undertaking one-to-one initiatives information to guide their implementation. Thank you in advance for the opportunity to hear your perspectives and gather your insights about the one-to-one computing initiative in your district/school.

*Hand out consent form and group sign in form

Interview Questions

- Planning steps in rollout
- Policies to support initiative
- Professional development activities, plans, and programs
- Challenges at each step of the rollout
- Successes in implementation
- Definition of success
- Technology, instructional, learning, and implementation goals
- Recommendations for other districts

Interview Questions

1. As we seek to learn more about your school or district, how would you describe your schools (district) to a family who was considering moving in the area?
    a. *Demographics*
    b. *SOL/test scores*
    c. *Community*
2. For the record, at what schools and grade levels have you currently deployed your technology?

3. With regards to your computing initiative, what steps did you go through to plan for your rollout?
4. What were some of the professional development activities and programs created to support the administrators and teachers prior and during the implementation of the devices?
    a. *How much advanced planning did you do?*
    b. *Are you following a prescribed plan?*
    c. *How much of your PD was provided by an outside vendor?*
    d. *How much of the PD was specific to the platform of technology you chose?*
5. What new policies did you implement to support the initiative?
    a. *Did you have to update your AUP?*
    b. *Do you have an equipment loan policy?*
    c. *Did you change any policies dealing with discipline?*
6. What challenges have you faced?
    a. *Why do you think you faced these?*
    b. *What could you have done to avoid these challenges?*
7. What criteria are you using to determine the success of the 1:1 program?
    a. *What sorts of evaluations have been completed, and/or being planned?*
8. What have you been most successful with in your implementation?
9. What were the long term and short term goals for your 1:1 program?
    a. *(Was it constructivist learning?)*
    b. *(If not constructivist): Do you have goals yet to fulfill?*
    c. *How long do you think you will need to realize these goals?*
    d. *Technology goals?*
    e. *Instructional goals?*
10. What would you recommend for another district starting a 1:1 program?
    a. *Would you recommend the same platform type? (Why?)*
    b. *Anything about your planning stages?*
    c. *Anything about professional development?*
    d. *Anything about being better prepared?*

Thank participants for their time. Ask if they have anything else they want to add that we didn't touch on.

Appendix J

REVISED
October 19, 2013
Interview Procedure and Questions to Read During Interview
**Hand out or have in place the Team Member Flyer and Interview Q's*
**Ask participants to introduce themselves and their job titles before turning on recording. Create seating chart.*

TURN ON RECORDING DEVICE NOW

Hello, I'm _____, (second person), (third person), & (fourth person). We are fellow educators and doctoral students in Educational Leadership at VCU. Thank you for graciously agreeing to allow us to gather your perspectives about practices related to the one-to-one computing initiative in your district/school.

We're hoping that the insights you share with us will guide and inform other schools/ districts that seek to implement a one-to-one computing initiative.

We are audio recording this session, but know that we will remove any personal identifiers when we transcribe the recording. In other words, we promise confidentiality and your anonymity as we work with the data we are gathering. (However, please be aware that you are in a group setting, and we cannot guarantee that everyone else in this room will abide by these same guidelines.) If, at any time, you have second thoughts about what you have said during this interview, you may ask to have your comments removed from the transcript.

We hold ourselves to high professional standards and plan to use this experience to provide fellow educators undertaking one-to-one initiatives information to guide their implementation. Thank you in advance for the opportunity to hear your perspectives and gather your insights about the one-to-one computing initiative in your district/school.

*Hand out consent form

Interview Questions

- Planning steps in rollout
- Policies to support initiative
- Professional development activities, plans, and programs
- Challenges at each step of the rollout
- Successes in implementation
- Definition of success
- Technology, instructional, learning, and implementation goals
- Recommendations for other districts

1. (Overall History) Could you describe your district before the 1:1 implementation?
    - *How would you describe the teaching styles before the 1:1?*
    - *What types of technology did you have?*
    - *What did your infrastructure look like before?*
    - *What types of software/subscriptions were used with students?*

2. (Overall History) For the record, at what schools and grade levels have you currently deployed your technology?
    - *Why did you choose that device and grade level?*

3. (RQ #1 Policy, #2 PD) What were the major milestones in the planning process?
    - *When did you start considering this?*
    - *How did you get funding for the initial implementation?*
    - *How do you sustain the funding?*
    - *How did you convince the tax paying community that this was a valuable use of resources*
    - *How did you know your school was ready for a 1:1?*
    - *How did you decide on staff development? Who is leading it?*

4. (RQ #2 PD) What were the long-term and short-term goals for your 1:1 program?
    - *(Was it constructivist learning?)*
    - *(If not constructivist): Do you have goals yet to fulfill?*
    - *How long do you think you will need to realize these goals?*
    - *Technology goals?*
    - *Instructional goals?*
    - *Financial goals?*

5. (RQ #2 PD) What were some of the professional development activities and programs created to support the administrators and teachers prior and during the implementation of the devices?
    - *How much advanced planning did you do?*
    - *Are you following a prescribed plan?*
    - *How much of your PD was provided by an outside vendor?*
    - *How much of the PD was specific to the platform of technology you chose?*

6. (RQ #1 Policy) What new policies did you implement to support the initiative?
    - *Did you have to update your AUP?*
    - *Do you have an equipment loan policy?*
    - *Did you change any policies dealing with discipline?*

7. (RQ #3 Challenges) What challenges have you faced?
    - *Any other challenges?*
    - *Why do you think you faced these?*
    - *What could you have done to avoid these challenges?*

8. (RQ #1 Policy, #2 PD) What criteria are you using to determine the success of the 1:1 program?
    - *What sorts of evaluations have been completed, and/or being planned?*
    - *Who is doing the evaluation? How many times? Is it going to be re-evalauted?*

- *How did you come to decide on that criteria?*
- *Were there pressures for other approaches?*
- *Are you willing to share the evaluation with us?*

9. (RQ #1 Policy, #2 PD) What have you been most successful with in your implementation?

10. (RQ #3 Challenges) If you could do it all over again, what would you do differently?

- *Would you recommend the same platform type? (Why?)*
- *Anything about your planning stages?*
- *Anything about professional development?*
- *Anything about being better prepared?*
- *What would you recommend for another district starting a 1:1 program?*

Is there anything else you would like to add that we didn't cover?

We had sent a list of documents we would like to collect in relation to your one to one initiative. Are any of those ready for us to collect at this time?

Appendix K

District Two Follow Up Questions

1. When you started the eMates pilot in the late 1990s, you mentioned starting grades 4 and 8. **Why were these grades chosen? Was there a plan to expand outward from these grades?**

2. You mention that now with the iPads that teachers have moved to the role of facilitator. **How specifically, do you see that happen? Is it in some new type of classroom behavior? In lesson plans (and how if in lesson plans), or in the ways they use technology?**

3. One of your ITRTs mentioned that with iPads in the hands of kids, instead of computers on carts, that using technology was more convenient. **How does learning, however, change in this newer, student-carrying tech, scenario? Does the convenience afforded teachers without using carts increase their use of tech? How students or teachers use tech?**

4. One of the ITRTs mentioned that with the iPads, a lot of worksheets have gone away. "With the iPads, we can disaggregate the data from the worksheets." My guess is, she was referencing a tool like iXL which collects student responses to math questions, and then teachers could track student progress, based on a standard, or individual question. **Does the iPad offer a different instructional experience aside from worksheets in this scenario, or just the added benefit of data for improving student outcomes?**

5. One of the ITRTs mention that "Kids are more engaged with iPads rather than a teacher writing on a SMART board." **Do teachers use marker and/or SMART boards less now, now that iPads are in use? What types of activities are students doing on the iPads to encourage this engagement, instead of watching a teacher use the SMART Board?** You might give us a lesson example, or mention apps that replace the instructional strategy originally undertaken by teachers using the SMART board.

6. We understand that the iPads came because of a need to go digital with textbooks. **Aside from the weight and convenience factor involved with digital textbooks, how do digital textbooks improve instruction? Because they are digital, are these resources used in different ways than you may have previously done with paper-based textbooks?**

7. On the summer institutes. You also mentioned four sessions of half-day workshops, where substitutes covered for teachers. **In your first two years, what did all the PD sessions look like (how many sessions, what time of year, and for how long)? How many people, on average, attended a session? Could people repeat sessions? Where the sessions differentiated on teacher ability level, grade level, or subject area? Have sessions been more on iPad use, or more on pedagogy with the iPads (you might answer this with 80/20, 50/50, or 20/80 to give an approximation of the percentage spent in training with iPads)?**

8. Parent meetings. I believe you said there were "a lot of make-up meetings" for parents. **How many meetings, total, does a school have to offer to get all parents on board? Is a private meeting with a staff member possible? How much people power, personal time did all the meetings take? Are there any plans on changing the format of these meetings, say, like using technology to make them more efficient?**

9. Your principal mentioned she does random checks of the iPads to see that they meet compliance with the student code of conduct. **What is done during these checks? Are parents notified that the checks will take place? How often do you or other staff do the checks? In a given year, how many checks (either a number or percentage of student population) do you (or your staff) complete at a school?**

10. An ITRT mentioned that "not having internet at home with kids is limiting… all kids can't use one of our textbooks because it requires online access." **Aside from putting internet in every home, is there a solution to this limitation? How much of a negative impact is not having the internet at home for kids with the iPads? Are there plans to improve the situation, either through low-cost internet, use of tools that do not require online access, etc.?** Your principal mentioned sending paper copies home of some materials. **Was this a solution for combatting the "no internet at home" scenario?**

11. You mentioned Apple not being more supportive with their tools to support school 1:1, especially at the beginning. **If you were to send Apple a list of things they still don't have right, now, what would you put on the list? Or, perhaps a more politically correct way to answer the question is… "What should school demand of their chosen vendor(s) to help support the deployment of apps and resources on computing devices in 1:1 environments?"**

12. You mentioned the project-based approach with MacBook Airs at Warrior Tech HS being something you hoped would trickle-down into the lower grades with the iPads. **How will you encourage this to happen? Is there are formal plan for PD in the works? Will it be personalized, by teachers through ITRTs, as needed? Will it be led by principals? What will this look like in Elementary or Middle School 2 years from now? 4? 6?**

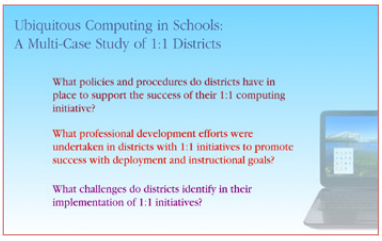
Appendix L

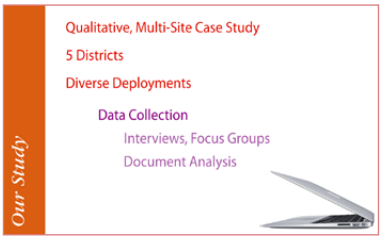
District Four Follow Up Questions

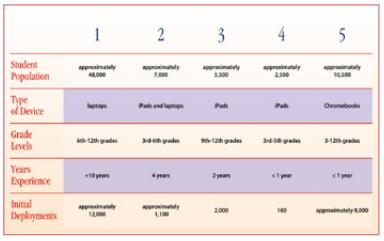
1. Could you describe your district before the 1:1 implementation?
2. What types of devices (and to what extent) were there before the 1:1? (ex. computer labs, 5 laptops in classrooms, etc)
3. Why did the district choose iPads? Why conduct the pilot at the pilot elementary? How did you know that the staff was ready?
4. Who participated in the deployment process?
5. What exact steps were taken to prepare for the iPad for deployment?
6. Where did the funding come from? How do you plan to sustain the funding?
7. How was the AUP modified in preparation for the 1:1?
8. Did Apple provide any type of training? If so can you describe what was covered in the training and who attended the event?
9. How did you present the 1:1 initiative to the community?
10. How often is the walk through data collection reviewed? Who reviews it? Do you plan to have any other forms of evaluation? Are you willing to share the walk through data with us?
11. If you could do it all over again, what would you do differently (if any?)

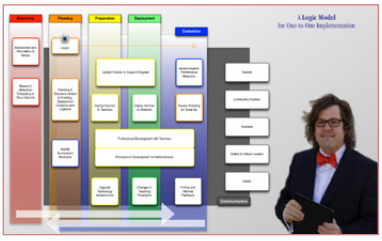
Appendix M

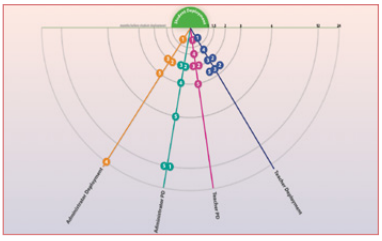
On March 28, 2014, we presented our findings and recommendations to our client district. On April 8, 2014, our team defended our project with our capstone committee at VCU. What follows are images of some of the slides produced for these presentations.

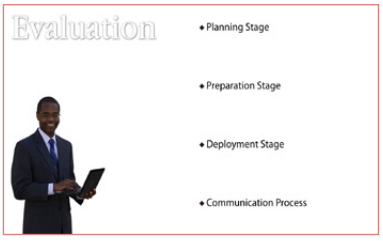


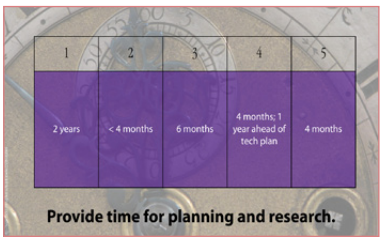




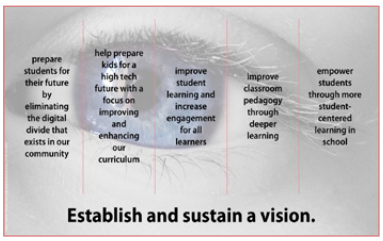


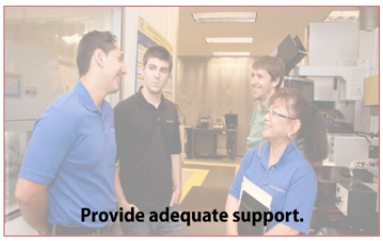


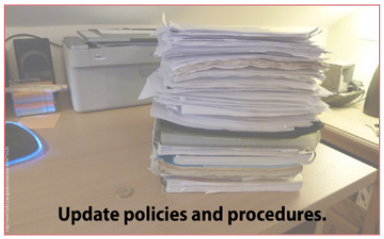




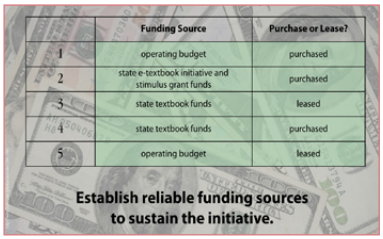

Check your infrastructure.

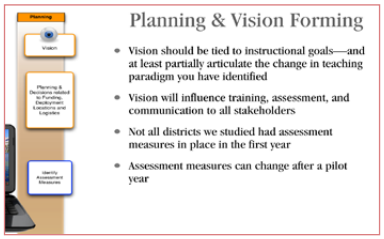

prepare students for their future by eliminating the digital divide that exists in our community
help prepare kids for a high tech future with a focus on improving and enhancing our curriculum
improve student learning and increase engagement for all learners
improve classroom pedagogy through deeper learning
empower students through more student-centered learning in school
Establish and sustain a vision.

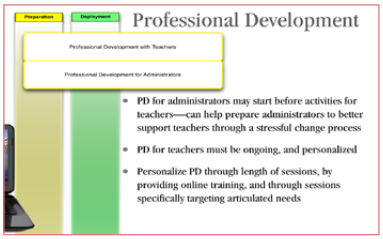

Provide adequate support.

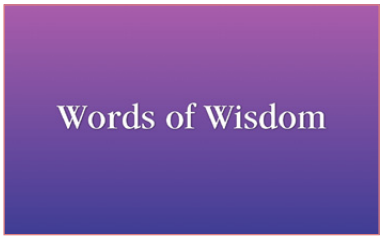

Update policies and procedures.

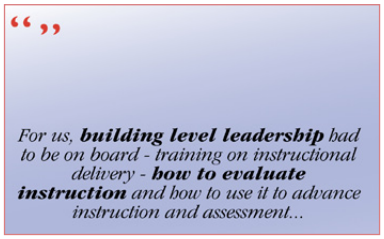

Establish evaluation criteria.

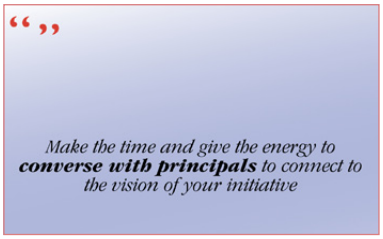

Funding Source
Purchase or Lease?
1 operating budget purchased
2 state e-textbook initiative and stimulus grant funds purchased
3 state textbook funds leased
4 state textbook funds purchased
5 operating budget leased
Establish reliable funding sources to sustain the initiative.


Planning & Vision Forming
Vision should be tied to instructional goals—and at least partially articulate the change in teaching paradigm you have identified
Vision will influence training, assessment, and communication to all stakeholders
Not all districts we studied had assessment measures in place in the first year
Assessment measures can change after a pilot year

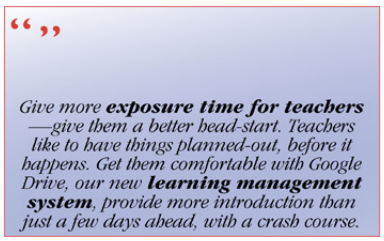

Professional Development
Professional Development with Teachers
Professional Development for Administrators
PD for administrators may start before activities for teachers—can help prepare administrators to better support teachers through a stressful change process
PD for teachers must be ongoing, and personalized
Personalize PD through length of sessions, by providing online training, and through sessions specifically targeting articulated needs


Words of Wisdom


For us, building level leadership had to be on board - training on instructional delivery - how to evaluate instruction and how to use it to advance instruction and assessment…


Make the time and give the energy to converse with principals to connect to the vision of your initiative


Educate your school board—and again—if it or your superintendent changes


Give more exposure time for teachers—give them a better head-start. Teachers like to have things planned-out, before it happens. Get them comfortable with Google Drive, our new learning management system, provide more introduction than just a few days ahead, with a crash course.


Two Recommended Books for Division & School Leaders
Every Child, Every Day
Mark A. Edwards
Michael Fullan
Stratosphere


Discussion

Endnote & Colophon

Seymour Papert wrote for U.S. President Carter's *Commission for a National Agenda* that he foresaw within a decade the capacity for schools to provide each student their own computer. He concluded his remarks by saying: "Unless we do this, tomorrow will continue to be the prisoner of the primitivity of yesterday" (http://papert.org/articles/president_paper.html). We also were inspired by the concept popularized by Steve Jobs as computers becoming so-called "bicycles for the mind." We believe education leaders would be well advised to consult the origins of ubiquitous computing and look beyond the capacity a one-to-one initiative offers students in being able to look up facts online. As a creative machine, the computer likely has its most promising capacity for education.

—Derrick Deloatch, John Hendron, Angie Kim, & Shawnya Tolliver

Our technical report was a collaborative effort, generated in *Google Apps* on both Macintosh and Windows-based computers. I then downloaded each chapter as a Microsoft Word file and imported them into Adobe InDesign CS 5. The aesthetic for this document was born from colors in the clothing we wore in photos that appear at the beginning, and our layout of an executive summary created for our client district. The font chosen for both documents is ITC Garamond Light Condensed, formerly the corporate font of Apple Computer, Inc. Figures and graphics include Adobe Myriad Pro. The "1:1" logo was designed to look like a mobile app icon.

—John Hendron