Evaluating Readiness for Technology in Schools: Developing Planning Tools and Critical Metrics to Prepare for 1:1 Programs

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Abstract

Technology use in education is rapidly expanding with varying results. The success of education technologies in schools depends on both the quality of the material presented through technology in terms of content and pedagogy and also the quality of the implementation of the program. With the acknowledgement that high quality materials are essential to the success of any technology, this thesis is concerned with the implementation of technology programs in schools, as it is impossible to utilize the technology for learning gains when students or teachers cannot access the materials. Prior research in education technology has not addressed readiness or planning practices for such large-scale programs as they exist today, specifically for 1:1 initiatives ("1:1" describes a system in which all students have personal learning devices, such as tablets or laptops).

The main objective of this thesis is to determine the best practices in preparedness and planning for large-scale technology initiatives in US high schools. The research is designed to aid school system administrators and policy makers in their technology decision-making processes through the creation of a rubric of metrics and a model for sustainable implementation. The rubric and model were informed by data gathered through a case study approach, focusing on schools that are currently implementing 1:1 initiatives. The rubric outlines a spectrum of potential readiness levels across a number of critical metrics and allows school leaders to self-assess their readiness for a 1:1 program. In addition to the rubric and sustainable implementation model, this thesis aims to determine best practices in planning for a 1:1 program. Through a second round of case studies and interviews with school leaders, past planning practices and gaps in knowledge and planning were examined. From the school leaders' reflections on best practices, conclusions for improvement of current planning tools were drawn. These improvements include the creation of mentor relationships for schools and the use of a thorough, yet simple, needs assessment that includes detailed timeline for implementation. Both the readiness rubric and the study of planning practices led to a number of policy recommendations not only for schools, but for all levels of government in support of effective technology use in education.

Thesis Supervisor: Eric Klopfer
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Chapter 1: Introduction

1.1 Background

As technology develops rapidly in all realms, technology in schools has followed a similar path of rapid expansion and development. From traditional media including print, audio, and video to internet-based applications and interactive media instruction through computers, schools have seen technology evolve over time (Zaied, 2006). Most schools in the United States now have access to a variety of electronic and digital equipment to aid learning.

In addition to investments in different types of classroom technologies (projectors, interactive boards, etc.), schools have begun making large technology investments in terms of the quantity of computers, gradually decreasing the ratio of computers to students. Where there was once a single computer for all students to share, there are now often enough devices for a 3:1 or 2:1 ratio. In fact, many schools have begun to adopt 1:1 programs by purchasing devices for every teacher and student. The term "1:1" describes the ratio of computational devices to students; that is, every student in a 1:1 program has his or her own device.

There are a number of reasons why schools have opted to increase the amount of technology in their classrooms. Though research has shown that teacher quality is the most important factor contributing to student achievement (Darling-Hammond, 2000), there are some functions that computers are uniquely suited to do in support of student learning. First, well-designed computer programs are able to differentiate instruction to a student's specific needs. This is difficult for a teacher to do because the needs and learning level of every child in the classroom differ. Despite a teacher's best efforts, differentiating to any level of precision for each student is nearly impossible. Similarly, computers are particularly well suited for adaptive learning, in which the program is able to continually challenge the student at the appropriate level and move along a continuum of learning at the right pace. Teachers are forced to move along in the curriculum even when some students are ahead or behind; computers can more easily provide enrichment and challenges for students who are ahead and remediation for those who are behind.

Because of its ability to do things that people cannot, technology can benefit students and teachers in number of ways. When used well, education technology has allowed teachers to make more engaging lessons, students to delve into content they would not have otherwise had access to, and administrators to reconsider the ways they think about the traditional classroom model. With personal devices, not only can students progress at their own pace, but they can also collaborate with other students digitally and learn from anywhere.

There are two sides to success in any education technology program: implementation and learning. Learning, though certainly the outcome that is more sought-after, cannot occur without a sound implementation of the device or software. However, it is important to note that a successful implementation is a necessary, yet not sufficient, condition for using technology to positively impact students. A successful implementation of a poor technology program will not enrich classroom learning. Successful use of technology includes thoughtful planning about not only the implementation, but also the technology itself and how it will help to achieve the learning goals as defined by the school. Without a fit between the technology use and the ultimate learning goals, the technology is an expensive and ineffective tool.

With the adoption of new types of devices and programs, schools must determine how to successfully implement, and problems in implementation are common. There have been a few particularly large, public failures in implementation within the past few years (Blume & Ceasar, 2013)[1]. When failure in implementation occurs, opportunities for learning are stifled and faith in education technologies in general is hurt. Though thoughtful planning for learning is essential for the success of any technology program, this thesis focuses solely on implementation of large-scale technology programs, and in particular, 1:1 initiatives. There is a lack of research in the area of readiness for 1:1 initiatives, which are becoming more common by the day; this work adds to the research on planning and readiness for implementation of 1:1 programs in US schools.

[1] The Los Angeles Unified School District (LAUSD) had particularly public problems with their fall 2013 iPad rollout, as the second largest school district in the US, LAUSD became the center of much media coverage because of their difficulties in implementation.

1.2 Research Description

The objective of this thesis is to evaluate the readiness and planning processes of schools for implementing educational technologies, specifically in terms of new 1:1 initiatives. The research draws on a diverse set of schools in the US currently implementing 1:1 technology programs. Through case studies of these schools and districts, this work was produced to aid school district leaders in better decision making for education technologies and to address the policy concerns of districts, states, and the federal government in constructing appropriate policies for innovation involving technology in schools.

This work is specifically focused on 1:1 initiatives in US high schools, though a few international examples are given in the background section. The devices used in the schools include tablets, laptops, and netbooks. These individual device initiatives have become popular in the higher grade levels as they give students the ability to conduct research independently, collaborate remotely, and develop "21st century skills" useful for college or jobs after graduation. High schools face a different set of concerns than lower grade levels, as the students are normally given their device to "own" for the school year and are responsible for taking care of the device during and outside of the school day. The decision to only include high schools in the case studies was intentional as they represent a majority of current 1:1 programs and face a set of unique issues in comparison to younger grade levels.

1.3 Objectives of Research

The purpose of this research is to aid school district leaders and policy makers in their technology decision-making processes. Through the development of a readiness rubric, the creation of a model for sustainable implementation, and the assessment of planning tools and processes, administrators will have more knowledge and be able to make better, more informed decisions related to technology and 1:1 programs. The research questions this thesis seeks to answer are the following:

(1) What infrastructure exists in US schools implementing 1:1 initiatives and how does it affect staff members' ability to effectively utilize the new technology?

(2) What are the administrative, technical, and training needs of teachers in the US as they implement 1:1 initiatives?
(3) What planning processes exist in schools implementing 1:1 initiatives?
(4) How could the planning processes be augmented by a readiness rubric or similar needs assessment for 1:1 initiatives?

In order to accomplish this goal, the following series of activities were central to the research:

- Evaluation of successes, failures, and challenges to implementing a 1:1 program
- Development of a rubric of metrics to measure technology readiness
- Creation of a sustainable implementation model based on best practices
- Assessment of the use of needs assessment and readiness tools in planning for 1:1 programs
- Recommendations for policy structures at the federal, state, and district level for 1:1 programs

Below, each activity is discussed more thoroughly.

Technology evaluation

The technology evaluation piece of this research stems naturally from the final goal of creating a model for implementation based on best practices. The first step in creation of the metrics and model is an evaluation of the technology that 1:1 schools are currently using. This evaluation considers both the successes and failures of schools in their implementations. It is important to note that this evaluation does not consider student outcomes, but instead, focuses on a model of implementation and readiness.

Rubric

The rubric of readiness categories will be created to specify not only the metrics themselves by which schools should measure their readiness, but also the spectrum of levels of preparedness (i.e. from 'needs improvement' to 'excellent') that a school may fall under. The rubric includes readiness in terms of technical infrastructure, school-level structures, and teacher

support. Schools beginning a 1:1 program, or considering beginning a 1:1 program, would use this rubric in order to identify areas in which to apply more resources.

Implementation model

In conjunction with the rubric, the sustainable implementation model outlines how a school could implement best practices for its 1:1 program. This model uses the best practices, as identified from the rubric, to inform planning. The model focuses on sustainability of the program, as measured through comprehensive planning for infrastructure, financing, and teacher supports.

Use of planning tools

In addition, the use of planning tools, including needs assessments and readiness rubrics, is specifically addressed. This is particularly salient given the creation of such a tool to aid school leaders in the development of proper infrastructure and supports for their programs. The examination of planning tools relies on interviews with school leaders concerning the use of planning tools and their merit in assisting in an implementation. Though this may serve as motivation for creating a readiness rubric, and therefore be better suited to open the discussion of needs assessments, there were very few similar tools in existence when this research began in 2013. Over the past two years, many planning tools have emerged and it is useful to determine where the strengths and weaknesses of these tools lie and the actual use of these tools in practice by 1:1 planning teams.

Recommendations for policy structures

The final research activity is to determine the appropriate policy structures for 1:1 programs at the district and state levels. Technology in schools is quickly evolving, especially large-scale individual device programs. There have been federal- and state-level initiatives to promote and assist this technology advancement, though these regulations and guidelines vary widely across states. At the district level, there are often local policies to regulate and support technology in classrooms as well. It is important to consider the wide range of policies that exist

and determine how these policies and processes could be improved. Given the rapid spread of individual devices for students, contemplating policies for technology in schools is central to the success of innovation in education.

1.4 Thesis Outline

This section outlines an organization of the thesis. The thesis is separated into ten chapters and the content of the chapters is summarized below.

Chapter 2 is the literature review. The literature review discusses barriers to implementation of education technologies, including teacher-level, school-level, and financial barriers. It also covers previous work on education technology evaluation frameworks in light of this thesis's objective to develop a useful tool for school leaders to evaluate readiness.

Chapter 3 introduces the current context of 1:1 programs in the US. Specifically, this chapter discusses technology in the classroom, including tablets, Chromebooks, netbooks, and laptops, as well as relative success of a few international initiatives. This chapter also looks at the variety of needs assessments for measuring readiness and their potential efficacy in aiding a 1:1 program.

Chapter 4 describes the methods used for both lines of inquiry in the research. First, the methods for creating the readiness rubric and sustainable implementation model are described. Second, the methods used in evaluating the use and methods of planning tools are detailed.

Chapter 5 presents the analysis done to determine best practices in 1:1 implementation. This chapter describes the infrastructure, planning, and teacher-related aspects of a 1:1 program in detail based on the results from the surveys, interviews, and analysis done to answer the initial research questions.

Chapter 6 summarizes the results of the readiness research. These results include the readiness rubric (which can be found in Appendix A) and the sustainable implementation model in terms of technical infrastructure, school financing and planning, and teacher support.

Chapter 7 presents the second section of analysis done to determine the use and merits of planning tools used by school leaders in planning their 1:1 initiatives. This section covers the use of such tools, the ideal planning tool as described the school leaders, and a comparison of existing types of planning tools.

Chapter 8 is a discussion of the results based on the analysis of the use and merits of planning tools. In this chapter, access to planning tools, gaps in existing tools, and proposed improvements to tools are discussed.

Chapter 9 discusses the current policy context of education technology initiatives at the federal, state, and local level. This chapter also includes recommendations for policy improvements and possible implications of these recommendations.

Chapter 10 concludes the thesis with a brief overview of the work and opportunities for future research.

Chapter 2: Literature Review

Research in the field of education is extensive, and accordingly, there is no shortage of research on education technology. A review of the literature identified a few particularly relevant categories, including barriers to implementation of technology and evaluation of education technology.

Implementation of any type of technology in schools is a complex process. There are a number of considerations that leaders must make when determining how to best incorporate technology into the curriculum for students. The literature addresses a range of barriers that schools and teachers face in implementation and also provides a series of useful frameworks for thoughtful implementation and programs. Most of the literature does not directly focus on 1:1 initiatives; however, it provides a useful background for this work and considering education technology implementations in general.

Though this research is not concerned specifically with evaluating education technology, the frameworks created through prior work and the metrics used to measure student success are useful in contemplating methods and best practices in implementation.

2.1 Barriers to Implementation

Schools and teachers often face barriers to implementation with technologies in the classroom. Research addresses the categories of teacher, school, and financial barriers to implementation.

2.1.1 Teacher-level barriers

One method of classifying the obstacles that present themselves in the classroom is extrinsic vs. intrinsic, as described by Ertmer (1999) in his meta-review on barriers to technology integration. The extrinsic (or first order) barriers include access, time, support, resources, and training. These first order barriers are school-level needs for successful technology integration through structures and supports that a school can (or cannot) provide. Without these structures, integration would be infeasible. For example, if the school does not provide support and

resources to students and teachers, it will be very difficult for the technology to be used successfully. Furthermore, Ertmer (1999) also observes a series of intrinsic, or second order, barriers including attitudes, beliefs, practices, and resistance. These second order variables are teacher-level, and present reasons why a particular teacher or classroom may not have success with the implementation. For example, if a teacher believed that the technology would not be helpful to students, then it is unlikely that the teacher would put forth a strong effort to use and integrate it in a meaningful way.

In a study of lower secondary schools worldwide, Pelgrum (2001) identifies the main categories of obstacles through an assessment that included 26 countries. His main categories of barriers include curriculum, infrastructure, staff development, management and organization, and innovative practices. The biggest barriers are insufficient numbers of computers and teachers' lack of knowledge and skills. Obviously, for a 1:1 initiative, an insufficient number of computers is unlikely to be a problem, however, teacher-level variables such as competence do pervade many studies. Other obstacles that were frequently cited by teachers include insufficient time for planning, lack of technical assistance, and inadequate training.

Through an additional review of the literature, Bingimlas (2009) presents a thorough analysis of the teacher-level barriers to technology implementation and integration. The research presents the following deficiencies often cited as difficulties: lack of confidence, lack of technology knowledge, lack of competence, and resistance to change and/or negative attitudes. Through this study, as well as others, it is clear that there are many teacher-level barriers (as well as ways to classify these barriers) to technology integration. Though schools attempt to address these obstacles through teacher training, additional resources, and technology support, teacher-level barriers remain a large hurdle for any education technology program.

2.1.2 School-level barriers

Other research efforts have noted that there are also many school-level barriers to implementation of technology in classrooms. These obstacles concern school structures that negatively affect the ability of teachers to effectively use the technology in their classrooms. One of the most cited school-level barriers is a lack of time. This time problem includes not only a lack of time to prepare for using the technology (planning and otherwise) (Becta, 2004), but also

a lack of time to plan technology-based lessons, explore Internet sites, and experiment with software (Sicilia, 2005). In another study, the most significant constraint on use reported by 86-88% of primary and secondary science teachers was also time (Osborne and Hennessey, 2003).

Furthermore, many studies report problems with support and training. A study in Turkey noted the specific problem of a lack of effective training (Ozden, 2007). This training problem goes beyond general training on the use of technology, but also notes issues in relation to proper pedagogical training (Becta, 2004; Cox, 2000). Many teachers need more assistance to understand how computers should support learning (Newhouse, 2002). Even when there is training support in schools, it is often a problem that the training is not specific or updated regularly (Balanskat, 2006).

Access and technical issues are also frequently referenced in the literature on obstacles to technology use in schools. Broadband access and slow networks are common problems that prevent teachers from effective use (Husing, 2006; Al-Alwani, 2005; Albirini, 2006). With a slow network, teachers are left waiting for websites, having difficulties with printers, and often being disconnected from the Internet. The need for support and maintenance of old computers is also essential to effective use (Husing, 2006).

2.1.3 Financial barriers

Schools may encounter a number of financial barriers to implementing 1:1 programs. First, it is useful to think about resource allocation in schools. Generally, regardless of the total amount of a school's budget, 60-63% is spent on instruction, including teachers' salaries and associated resources. The remainder of the budget is spent on student services, administration, building operation and maintenance, food services, and transportation (Monk, 1997). This ratio is fairly constant across schools of differing sizes and local circumstances. Technology may impact a number of different pieces of this budget, including instruction, as an aid to learning, and building operation and maintenance, as the physical infrastructure impacts the use of technology in the classroom.

Schools are constantly under pressure to provide an excellent education for students using as few resources as possible. This difficult task requires district leaders to make a number of judgment calls on the best way to allocate resources. In terms of technology, a school with a

typical amount of computers for students (a 3:1 ratio, after accounting for classroom computers and computer labs) costs a district an average of $298 per student per year. A school that has a 1:1 technology program spends an average of $593 per student per year, though schools report annual program costs ranging from $250 to $1000 per student (Greaves, 2008). With the advent of better, faster, and cheaper technologies, including inexpensive devices, such as Chromebooks, it is likely that this cost is decreasing. These costs include the necessary hardware, software, and professional development for teachers. A 1:1 program also may account for some cost-savings for a district, as less printing and paper materials become necessary and student materials gradually become digital (Greaves, 2010).

To make the jump to a technology-intensive environment, schools sometimes opt to apply for outside grants to seek increases in the district budget allocation to technology. Some states have also begun to assist schools looking for a technology upgrade. For example, Massachusetts passed a bill in 2014 (H. 3770: "An Act Financing Information Technology Equipment and Related Projects") that makes targeted investments in the state's technology infrastructure including increasing broadband access for certain communities. The bond specifically grants $38 million to a pilot grant program for school connectivity to bring high-speed Internet to schools in underserved parts of Massachusetts (MA Broadband Institute, 2014). Such state-sponsored initiatives aim to help districts finance the significant infrastructure improvements that are often necessary to develop large-scale technology implementations.

2.2 Education Technology Evaluations

Evaluation of educational technologies is often difficult because it involves many structural, institutional, and curricular reforms. Ideally, lab-based experimental methods would provide evidence for the efficacy of particular programs, but this is often infeasible, and still would not address all difficulties (Merrill, 1995). Much of the literature describes the problems with addressing the impact and evaluation of technology in schools. Gomez and Pather (2011) pose the need for a shift in general technology evaluation from a focus on the tangible benefits to a focus on the intangible benefits, such as empowerment, self-esteem, and social cohesion. There is a parallel problem in evaluating any kind of education initiative, as these evaluations usually focus on the quantifiable achievement metric of test scores, but miss any intangible benefits that

may occur as a result of the intervention. Because it is difficult to measure changes in students outside of academic achievement, evaluations based on test scores may miss the mark if a school is interested in non-cognitive benefits to technology programs.

2.2.1 Frameworks for evaluating education technologies

A variety of frameworks exist for evaluating education technologies. This literature is useful in providing a lens to view the major concerns of using technology for schools, teachers, and students. Though there is not a single "best" way to determine efficacy of technologies for learning, each framework is designed to highlight significant outcomes and challenges. The following frameworks discuss not only measuring efficacy, but also selecting the appropriate technology for use, determining technical literacy of teachers and students, and choosing appropriate software to meet specific learning goals. These are all important considerations in planning for technology use and therefore, highly relevant to this research.

Measuring efficacy

Efficacy in education is difficult both in terms of definition and measurement. First, generally an "effective" intervention is defined as one in which student achievement is positively impacted. However, there are many other definitions that success or effectiveness could encompass. For example, student engagement and enjoyment of learning could be an important quality to measure for a certain intervention. In addition, other education aims may be to increase teamwork or collaboration skills among students to better prepare them for a work environment. These skills could not be measured on a simple test of achievement, and therefore, a single definition of "efficacy" is hard to determine.

Furthermore, even with a clear definition, measurement is difficult. Taking the example of student achievement in a content area (i.e. mathematics, reading, or science), countless governments have attempted to measure how much a student is learning in the classroom. Not only have these attempts been met with a wave of controversy, questioning the motivation for such testing, but also, measuring student learning via a standardized test is inherently difficult to do. There are questions concerning the validity of test questions, depth of necessary knowledge,

and external confounders, such as socio-economic status and health issues. It is not necessary to look far into the debates in the world of education to come across the testing debate, and these issues present reasons as to why.

Even with the difficulties associated in measuring efficacy, it remains important for governments, schools, and teachers to ensure students are learning. Jenkinson (2009) expresses the need for evaluations to be concerned with not only what is being learned, but also how students are acquiring new knowledge. He notes that evaluation frameworks should take a flexible approach to measuring learning effects and focus less on knowledge outcomes and more on the process by which understanding develops.

One particular framework for assessing the contribution of technology on learning outcomes is presented by Jones and Paolucci (1999). Their framework separates the components of technology-aided learning into three major segments: instructional objectives, delivery system, and learning outcomes. Many aspects of this framework are useful to consider in implementation of a 1:1 program, including defining the particular objectives for learning, determining the locus of control for the technology, and shaping the hierarchy of learning outcomes that will be achieved in terms of lower- and higher-order thinking for students.

Selecting appropriate technologies

Ainsworth (2008) notes that the following questions should be asked in evaluations of education technology:

- Who benefits from learning with specific types of multimedia?
- How do people learn with multimedia?
- How does learning with multimedia change over time?
- How does the wider context influence learning with multimedia?

These questions are important to keep in mind in planning for technology implementation in schools and considering these questions should be part of the planning process for school leaders. One particularly relevant question is, “Who benefits from learning with specific types of multimedia?”. This question leads into the concern of selecting appropriate technologies for the

given context. The context could include the district, grade level, or group of students for which the technology is implemented. Other frameworks for selecting appropriate technologies consider criteria such as cost, reliability, interface, training requirements, and ease of installation (Zaied, 2006). Regardless of the criteria that are used to select a device, this is a process that all technology leadership teams should complete in order to determine which technology to select to meet a need in a school.

Determining technical literacy

Technical literacy represents a significant barrier to implementation faced by both teachers and students. Davies (2011) defines technology literacy as:

> *"Technology literacy in educational situations is defined as the ability to effectively use technology (i.e., any tool, piece of equipment or device, electronic or mechanical) to accomplish required learning tasks. Technology literate people know what the technology is capable of, they are able to use the technology proficiently, and they make intelligent decisions about which technology to use and when to use it."*

Educators need to understand how to teach with technology while developing the technology expertise of their students in order to create a successful technology-based learning environment. Davies presents a framework that is designed to aid teachers in understanding, evaluating, and promoting effective technology integration while assessing technology literacy of their students. The framework could also be altered slightly to apply to assessing teachers' technology literacy. In either the student or teacher case, the framework presents a useful way to contextualize how comfortable learners[2] are with technology.

The framework identifies three levels of literacy for technology: awareness, praxis (i.e. training), and phronesis (i.e. practical competence and wisdom). The awareness phase happens when learners are exposed to technology, know what it does, but do not use it proficiently. In the praxis stage, learners become familiar with the functionality, can accomplish specific tasks using

[2] "Learners" in this case refers to both students and teachers as learners of technology.

the technology, and can explain how the technology accomplishes the task. In the final stage, phronesis, learners are adept at using technology, can use it in authentic situations, and understand why it is being used.

Training and practice are both necessary for developing technology literacy in education. This framework presents the important idea that though adoption can gauge comfort with technology, administration teams should not rely on adoption as the key evaluation indicator. Instead, students should be able to see how technology can aid their learning in accomplishing objectives and teachers should see how the technology aligns to learning objectives. Ultimately, at the phronesis level, students and teachers are able to answer the same question in regard to their technology use: *Why is technology being used and how well is it being used to accomplish the learning goals?* (Davies, 2011).

Choosing software

Though choosing software often happens after implementation, the process by which teachers are able to select and acquire software should be considered in the planning stages. DeFreitas and Oliver (2006) examine this process in relation to choosing appropriate simulations and games to meet learning goals, but their framework can easily be applied to any other app or piece of software that a school or teacher is considering. They note that there are four dimensions of their framework: context, learner attributes, internal representational world, and process of learning. Context, learner attributes, and process of learning are all directly applicable to any software selection process. The idea of considering an "internal representational world" is more specific to games and simulations where a "world" exists, but could also be generalized to the interface or interaction required between any app or software and the learner. The questions they ask in the creation of the framework are the following:

- Which game or simulation should be selected for the specific learning context?
- Which pedagogic approaches should be used to support learning outcomes and activities?
- What is the validity of using the chosen game or simulation?

Replacing “game or simulation” with “software” or “app” gives a generalized and applicable version of the questions that teachers and administrators could ask in making their choices for software. This software selection framework allows decision makers to determine which technologies fit the learning goals most appropriately and how technology best integrates with pedagogy and curriculum. Furthermore, the considerations around learning outcomes and activities demonstrate the importance of classroom-level implementation, as without solid pedagogy-backed and goal-oriented decisions, a technology initiative will not meet the needs of students.

2.2.2 Student performance metrics

In conducting evaluations, there must be a set of metrics to define “success”. Usually, the most straightforward metric to use is test scores, and many evaluations of educational technologies focus on the impact of the technology in terms of standardized test results. However, though a gain in test scores is usually widely touted as an increase in achievement, some studies have shown that a score on a single test could be impacted by other factors directly related to the test and not to learning, and the learning gains may not be generalizable (Glewwe, 2003). Therefore, it is wise to be cautious in interpreting studies on achievement in education, as there may be other variables affecting test scores.

Aside from concerns about biased evaluations if test scores are the only metric for success, it is also important to consider the impact education technologies can have on students in other areas besides academic achievement. Because computers are pervasive in higher education and the workplace, students might develop important technology-related skills that could benefit them later in life from using computers in the classroom. A sense of “digital citizenship” has become an emphasis in many schools, and greater access to technology would aid the development of these skills (Ribble & Bailey, 2007). Lastly, evaluations do not usually emphasize the intangible skills that students can develop from technology use, such as social collaboration and cohesion (which, admittedly, would be very difficult to measure), but these skills might be just as beneficial to students in the long run as the tangible benefits, such as increases in test scores (Gomez & Pather, 2011).

In evaluations on 1:1 programs, there have been efforts to measure many variables related to student impact, including test scores, absenteeism, discipline, and engagement. A number of studies have reported a decrease in absenteeism as a result of implementing a 1:1 program (Lemke & Martin, 2003; Texas Center for Educational Research, 2008). Meanwhile, in Alabama, a study showed a 29% decrease in school-wide discipline programs in conjunction with a laptop initiative (Intel Inc., 2008). Furthermore, studies have shown that students are more interested and engaged in learning when using technology (Lowther, 2005; Gulek & Demirtas, 2005). Of course, student achievement outcomes have also been central to a number of studies on technology. Technology-based programs have been shown to improve writing (Jeroski, 2003) and potentially mathematics – though to a lesser extent (eMINTS National Center, 2007).

Though there are many possible metrics for measuring the impact of technology in the classroom, it is important to note that this report does not focus on student outcomes. The research is instead focused on readiness, with the acknowledgement that the student outcomes may very well be the most important indicators of success, but they cannot occur if a school does not have the proper structures and supports in place to succeed in implementation.

2.2.3 Technical infrastructure

More closely related to this research is the evaluation of the technical infrastructure associated with technology in the classroom, though there is less prior research on the subject. Pelgrum (2001) presents the most cited variables pertaining to technology support personnel, including: adaptation of software to fit school purposes, use of multimedia applications, evaluation and selection of instructional software, and integration of computers in class subjects. These variables can often be barriers to implementation of technology in the classroom, and are some of the most cited obstacles by teachers and administrators to using technology in education.

Chapter 3: Current Context of 1:1 Programs

To provide background for this work, it is necessary to understand the current context of individual device programs in the US and around the world. This chapter outlines the main types of 1:1 programs in the US, a few examples of programs in other countries, and the biggest players in the industry. In addition, the variety of needs assessments that exist for planning a 1:1 program are considered, in light of the effort to create a research-based readiness rubric through this work.

3.1 Technology in the Classroom – Trends in the US

Large-scale 1:1 technology initiatives in the US are quickly taking hold in districts across the country. There are many types of devices selected for these programs, but the major varieties in the market are iPads, Chromebooks, netbooks, notebooks, and laptops. Figure 1 (below) shows the sales of tablets, netbooks, Chromebooks, and notebooks in the US K-12 education market in 2013 and 2014.

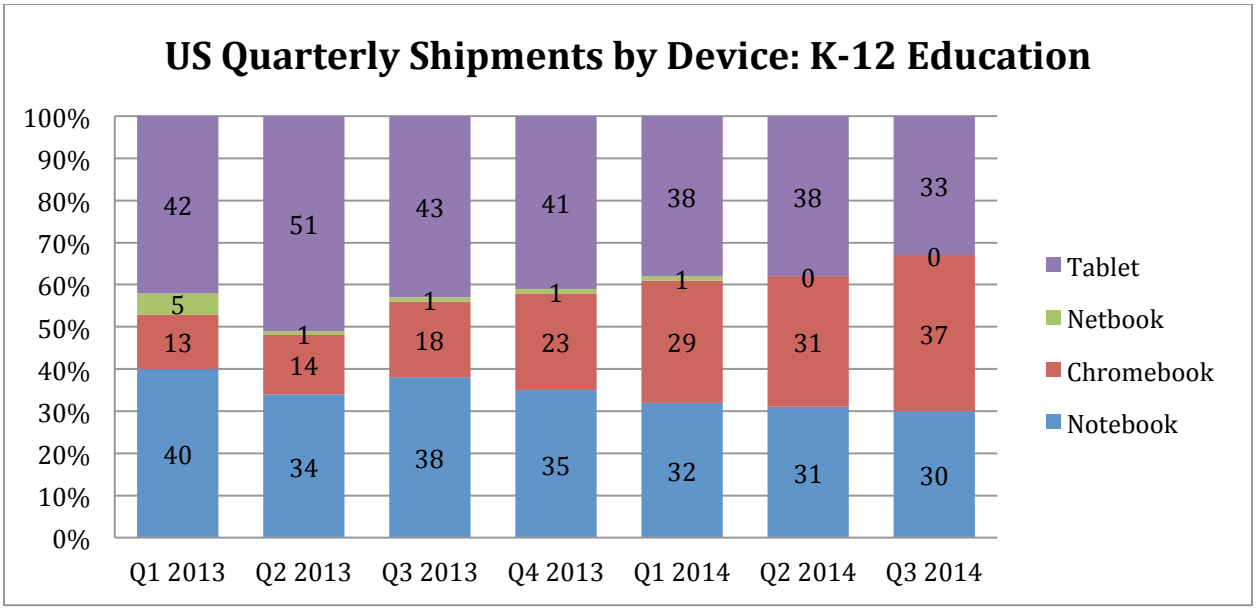

Figure 1. Quarterly Sales by Device in the US K-12 Education Market (2013-2014) (Futuresource Consulting, 2014)

As can be seen in the table, Chromebooks have grown in popularity quickly and steadily in the past two years, though netbooks and tablets continue to have strong market shares. Because Chromebooks were largely non-existent in schools until the 2013-2014 school year, there are still far more schools using iPads (or other tablets) and notebooks than Chromebooks. However, with the introduction of many new education-friendly devices in recent years, it is likely that market shares will continue to shift as schools try to make the best decisions for their educational goals from a larger variety of options.

3.1.1 Tablets

Though there are a number of competitors, including Google and Samsung, Apple has dominated the domestic education tablet market since the rise of 1:1 programs. Apple's share of the education tablet market has been upwards of 85% in many sales quarters over the past few years.

The offerings in Apple's educational app store exceed the number of apps available for other types of devices, and include resources for a variety of content areas. Conveniently for teachers, the educational apps are organized by grade level and content area. As an Ed Surge blogger states, "Whether it be the newest release from Motion Math Games, an interactive presentation from Nearpod, or new monsters on behavior-tracking system Class Dojo, the app store delivers the latest innovations" (Mirchandani, 2013).

Furthermore, the large touchscreen display is useful for more creative educational endeavors such as drawing or video production. It also lets younger children interact in ways that they might not be able to on a typical computer. For the younger students, the elementary-level apps are designed such that fine motor skills are not as necessary, as large objects and drawings take up most of the screen. For higher grade levels, the apps often become more detailed and require more precise interaction.

3.1.2 Chromebooks

Though iPads did not have very much competition in the non-laptop education device market a few years ago, Google's Chromebooks are quickly becoming a competitor in the US.

The iPad still dominates the tablet market, but in the broader education device market, Chromebooks are becoming more popular. In late 2014, Chromebooks overtook iPads in sales. In the third quarter of 2014, 702,000 iPads were sold to schools, in comparison to 715,000 Chromebooks (Eadicicco, 2014). Many argue that Chromebooks fulfill different needs than iPads in the classroom, as they are marketed as a more business-focused device than the sometimes more "recreational" iPads (Mirchandani, 2013). Chromebooks are also significantly less expensive than iPads, and in resource-constrained schools, price is an important consideration. Despite the significant differences in structure and functionalities, many schools make their device decision between iPads and Chromebooks.

Google Apps for Education is available through the Chrome App Store and provides a wide array of resources for teachers and students. Similar to Google's other products (gmail, Google calendar, Google docs, etc.), students have an account, which they can access from any device. With Google's single sign-on (SSO), when students log in to any device, everything they use on Google is automatically synced and ready for use. For some schools, using the Google platform for everything allows for a desirable streamlining of resources and communication between teachers, students, and administrators. Google's cloud-based system aids in collaboration between students and file storage, as everything can be stored online. However, this also means that an Internet connection is always necessary to use the device, unless students are operating in the off-line mode, which is a deterrent for some schools.

Figure 2 (below) outlines the major differences between the iPad 2 and Samsung's Series 3 Chromebook. As can be seen in the figure, the iPad has a longer battery life and wider variety of apps, while the Chromebook offers a lower price and access to flash-based applications, among other differences. Many administrators have done and will continue to do similar comparisons in order to determine the best device for their 1:1 programs.

	iPad 2	Samsung Chromebook
Size	9.7 inch screen 1.44 lbs.	11.6 inch screen 2.2 lbs.
Battery Life	9 hours of light usage (less with intense usage)	6.5 hours
Storage	16GB - 64GB	16GB + 100GB Google Drive
Keyboard	On-screen virtual	Full-sized
Price	$499-$699	$249-$329
Support	90 days telephone support (option to buy AppleCare)	24/7 support from Google
Warranty	1 year limited	3 year extended
Media Input	Microphone Headphone jack Apple Dock connector	Microphone Headphone jack 2 USB ports 4-in-1 memory card slot
Camera	2-way webcam with rear HD	Webcam
Flash-Based Media	Cannot access/display	Can access/display
Management	Difficult (iPads are meant to be personal devices) Up to 5 apps and updates can be pushed out to devices	Easy, web-based admin panel Unlimited apps/updates can be pushed out to devices
Software Updates	Manual	Automatic
Apps	Over 150,000 in store	Limited choice but growing daily
Customize	Customizations stuck to each individual device	Customizations linked to accounts

Figure 2. iPad vs. Chromebook: A comparison of key features (Rao, 2013)

3.1.3 Netbooks

Though Google's Chromebooks are gaining market share against the previous dominance by tablets and laptops in the K-12 education market, Microsoft has made some inroads with their

education products as well. Microsoft partners with PC producers such as Lenovo, Dell, and Acer to produce Windows-based devices, which allow students to use a wider variety of software without reliance on mobile apps. The Windows 8 devices are marketed as superior to the Chromebook and iPad mainly on their capacity to run the full Microsoft Office software suite and their ability to function well in schools where bandwidth is a concern. Microsoft's OneNote software is another education product that can be packaged with the devices to aid students in note taking and organization (Microsoft, 2015).

3.1.4 Laptops - Maine Learning Technology Initiative

Though many schools are looking for a lower-cost and smaller-sized option for their students, there are also schools that use a traditional laptop for 1:1 programs. One of the biggest examples of this type of initiative is in the state of Maine, which is home to the *Maine Learning Technology Initiative.* This initiative, which began in 2002, gave Apple MacBooks (formerly iBook G4's and G3's) to all public school 7th and 8th graders (Maine.gov, 2011). The middle schools received state funding for "software, hardware, network infrastructure, warranties, technical support, professional development, and data-backup services"; every piece of the program was covered by the state, and schools did not have to supply their own funds (Ash, 2009). In 2009, the program began expanding into high schools; however, the high schools only received funding for installing wireless networks into their buildings, and for this reason, were allowed to opt into the program. As a result, only 50% of high schools in Maine chose to participate in 2009, the first year of the high school initiative. (Ash, 2009).

One problem that many schools have run into is integrating Apple products into their already-existing infrastructure for PCs. In these situations, schools were forced to buy other expensive products in order to successfully integrate the MacBooks, and found themselves with very large financial burdens (Trotter, 2004). Schools participating in the initiative also need to pay technicians to maintain the network and fix network- and device-related issues, which is contributes to additional expenses.

In 2013, districts in Maine were given the option to remain with Apple products or switch to an HP Windows laptop. Given the option, 90 percent of districts stuck with Apple, while 10 percent went with HP. Of the Apple contingent, 60 percent of districts chose to switch to iPads

(teachers received MacBook Airs and iPad minis), while the remaining districts that chose Apple selected MacBook Airs for both teachers and students. All non-Apple districts received HP Windows laptops for all teachers and students (Maine Dept. of Education, 2013).

3.1.5 Bring Your Own Device

Another popular option that schools have begun adopting for 1:1 computing in the classroom is a Bring Your Own Device (or "BYOD") model, where students purchase and bring their own technology into school. With a BYOD program, schools are able to cut down on the immense costs associated with buying devices for all students. As described by Ed Tech Magazine, "A BYOD initiative overcomes this access hurdle, much as one-to-one computing programs do, but without the capital costs associated with purchasing the technology or the need to refresh, support and train users. With BYOD, students are responsible for figuring out and fixing their own devices." (CDW, 2012).

One common concern with BYOD programs is equity. For a BYOD initiative to be successful, all students must have access to devices, and in low-income communities, this may not always be feasible for families. Some schools have chosen to solve this problem by loaning devices to students or giving families stipends to purchase devices or pay for Internet access at home (CDW, 2012). Not only do schools choose to deal with these issues in a variety of ways, but there is also significant variety among BYOD programs. Some schools give students the option to BYOD, and a device is not required, while others mandate that students bring devices. Some schools do not care which type of device students bring (laptops, tablets, or even phones), while others are "iPad BYOD" or "laptop BYOB". Schools can choose how they want to implement such a program, and with these choices will come unique sets of benefits and barriers.

3.2 Technology in the Classroom – Global Initiatives

Technology is seen as a way to improve education for students all over the world. Recent years have seen the rise of MOOCs (Massive Open Online Courses) and sites like Khan Academy, dedicated to improving access to content. Given these trends in education technology, many other 1:1 programs exist throughout the world. A few examples are explored here, though

new programs are continually developing. One Laptop Per Child (OLPC), FATİH in Turkey, and Aakash in India are some of the largest-scale programs to date and are worth mentioning to further provide context for this research.

3.2.1 One Laptop Per Child

One of the first and most publicized 1:1 initiatives was the One Laptop Per Child (OLPC) program developed by former MIT Media Lab Director Nicholas Negroponte. Negroponte introduced OLPC in 2005 as an innovative way to address the disadvantages in developing countries in education, giving students a means to teach themselves content and also help each other learn (Kraemer, 2009). The program's main feature was a $100 laptop, which was sold to developing countries at a discount. Sales for OLPC were much lower than predicted due to unforeseen organizational and development costs and other challenges in implementation. Many of the OLPC devices went unused in classrooms in developing countries because there was little training or support offered to teachers, who were largely unfamiliar with using technology in education. As the initial results of the program became public, many governments either opted out of ordering devices or did not order additional devices as planned.

Given the problems incurred by OLPC and the continued demand for technology in education, competitors have seized some of the opportunities in this market. Shortly after the first deployments of OLPC laptops, interest in classroom technology was sparked both internationally and in the US. OLPC did sell some devices domestically, however, other competitors began to quickly enter the market space. One of the first to take advantage of this opportunity was Intel, which introduced the Classmate netbook, a low-cost computer that runs Windows. Partnering with Intel, Microsoft also introduced a $3 bundle of Windows and Office (Stecklow & Bandler, 2007). Other alternatives to OLPC and Classmate have also been developed (such as Mobilis, a netbook developed by an Indian software company), and have created competition in the market for educational technologies in developing countries. This competition not only pushed OLPC out of the market in many cases, but also created a buzz around low-cost 1:1 programs in developing countries.

3.2.2 FATİH (Turkey)

Outside of the US, other countries have chosen to implement the tablet 1:1 program as well. One very large example is the FATİH project in Turkey. This government-sponsored initiative started in 2012 and aims to put a tablet in the hands of all 17 million public school students, from pre-school to high school, by 2015. Teachers will also receive the tablets, which will come loaded with e-books and class lessons. In addition to the individual tablets, all classrooms will be equipped with a Smartboard. In a report released by the government in 2014, statistics showed that in the first two years of the program, the government has failed to meet its goals in distribution of tablets to students, distribution of Smartboards to classrooms, and upgrades to infrastructure in schools. Relative to the goals set forth by the Ministry of Education, in 2014, Turkey had only distributed tablets to 50% of students and Smartboards to 30% of classrooms. In addition, there were planned upgrades to infrastructure for 2,800 schools, yet only 135 schools were upgraded in 2014 (Demirdoven, 2015). Though the project is still underway, the Ministry is struggling to meet its goals and facing much criticism because of its poor planning and inadequate management.

3.2.3 Aakash (India)

Another example of a large-scale tablet initiative is in India, where the Aakash tablets are part of a government-sponsored effort to bring technology into university classrooms. These tablets are produced by the British-Canadian company DataWind and are currently sold for $58 to the Indian government, which then subsidizes them for students. Previous Aakash models were sold at a lower price, though they encountered a number of problems including being slow and unresponsive (Hardawar, 2013). The upgraded version of the tablet, “UbiSlate”, serves simple purposes, but upgrades in hardware have addressed the previous issues and the tablet will allow for basic Internet and word processing functionality (Velayanikal, 2014). In 2013, the Indian government ordered 100,000 of the upgraded Aakash 2 tablets with plans to distribute them largely to university students at a subsidized rate (Mims, 2013).

3.3 Needs Assessments for Measuring Readiness

Recently, many needs assessments and readiness checklists have been created to use in planning for 1:1 initiatives. This is not surprising given the sudden surge of 1:1 programs and the acknowledgement that needs assessments are critical for success in an implementation (Schrimshaw, 2011). Many of these tools were created at about the same time (2012-13) and provide an interesting set of diverging perspectives on the problem of implementing 1:1 programs. The tools often cover some subset of the following issues found in implementation: infrastructure, teacher training, apps and resources, and management. Though few tools are based in a rigorous research methodology, there exist a variety of tools that school leaders have at their disposal during planning. These tools vary widely in scope and detail as is described below.

The main categories of tools (from least to most detailed, in terms of guidance) are as follows:

- Blog posts
- Checklists
- Recommendation guides
- Team-based needs assessments
- Fully prescriptive rubrics
- Open-ended readiness questionnaires (used in conjunction with a consultant)[3]

It is possible for a blog post to contain significant amounts of detail or for an open-ended readiness questionnaire to only contain the most basic questions about a school. However, from the author's significant research into these types of planning tools, this is the typical hierarchy of level of detail, though it is certainly not definitive.

[3] Though this final category differs significantly from the others in terms of structure and cost (all of the others are free resources), it is worth noting. Especially as many schools look for advice and leadership outside of their district-based human capital during implementation, a needs assessment coupled with phone calls and/or visits from a consultant is an option that some schools choose to utilize.

School leaders or departments of education generally create these resources. Most planning tools are anecdotal in terms of research and based upon the experience that a school leader has in directing a single large-scale technology implementation. That being said, these tools still can be useful references for schools working on a very similar project. They also provide a useful lens to reveal where pitfalls in implementation can occur. However, because these are not based in research across a number of schools, it is hard for these guides to be comprehensive, but in most cases they are not designed to be.

In some cases, education researchers create tools. These types of tools are generally more thorough and funded through grants from foundations and the government. One such example is the Project 24 Tool, which was created by the policy and advocacy group Alliance For Excellent Education and associated with their joint Future Ready Schools initiative that is partially funded by the US Department of Education (Alliance For Excellent Education, 2015). Another example is International Society of Technology in Education's (ISTE) Technology Support Index, which was created through research funded in part by the Gates Foundation (AASA, 2015).

3.3.1 Blogs

Blog posts are likely the most common type of tool available, but the least comprehensive. These are generally very anecdotal in nature, as school leaders often write blog posts about their unique experiences in 1:1 implementation. Posts are usually targeted towards a specific program, problem, or outcome and can be useful for schools facing or working towards something similar. For example, a school leader might write about the difficulties of a successful rollout with a school population of over 2000 students; this would be useful for a similarly-sized school looking for advice on a successful rollout, but it is not generally useful to all audiences and certainly not comprehensive. Other bloggers focus on specific apps that can be used in the classroom or ways to use social media with students. There is a world of online content dedicated to technology in schools, and much of it exists in the form of online posts. Whether blogs or more formal news articles, this content is not designed to be used as a full implementation tool for a leadership team, but more likely a curious teacher looking for new ways to engage students.

In contrast to the specificity of a post about the latest app or pedagogical technique with technology in the classroom, there are also many blog posts that are extremely general about technology and 1:1 programs. For example, a plethora of "top 10" type lists exist, in which the author outlines a number of considerations for implementation or general strategies for success. These tend to be a good starting place for leaders thinking about a 1:1 program, but would not provide the detail necessary for planning a full implementation.

Education blogs and magazines such as Education Week, Edutopia, and EdSurge frequently publish this type of content, and the variety in topic areas is as wide as the differences in scope of these articles. There is enormous variability in terms of topic area, scope, and reliability, making blog posts useful for background knowledge and a source of opinions, but less useful as formal planning tools when considering an entire implementation.

3.3.2 Checklists

Checklists are designed to be simple with the basic steps necessary to implement a 1:1 program, or a specific element of the program. Generally, checklists do not provide detail about how to implement specific steps, but instead provide a very basic framework. Some toolkits for implementation contain checklists as a piece of the package, such as the Consortium for School Networking (CoSN) toolkit, which includes a series of checklists and self-assessments for superintendents and technology leaders (CoSN, 2015). Other checklists are stand-alone tools that are designed to aid school leaders in addressing a piece of the 1:1 implementation puzzle.

An example of a checklist for 1:1 programs was created and presented by education technology researcher Justin Reich recently at MassCUE (Massachusetts Computer Using Educators). The presentation, titled, "A Leadership Checklist: Getting beyond pockets of excellence," was shared through a blog post on Education Week's website. This checklist is an example of a tool that directly addresses one aspect of implementation. In this case, Reich was discussing and presenting a checklist of items on how to change teacher practice and student learning during a 1:1 implementation (Reich, 2014).

Other checklists address the entirety of steps that schools must go through to implement a 1:1 program. For example, Apple, in partnership with President Obama's ConnectED initiative, is supporting technology initiatives in dozens of low-income schools throughout the country. As

a piece of this support, Apple provides a checklist to the schools for their implementations. This checklist includes steps for program launch, planning, infrastructure deployment, teacher rollout, student rollout, and ongoing support (Apple and ConnectED, 2015). Each of these categories has a few steps, which outline a high-level structure for how to implement a 1:1 program. While this tool provides a useful starting point for schools, it does not provide the detail necessary to thoroughly plan how to take the actions to complete each of the steps.

3.3.3 Recommendations with self-diagnosis

Many needs assessments take the form of a set of recommendations for the ideal implementation and then allow school leaders to self-diagnose their current reality in comparison to the ideal. The Arizona Department of Education has created this type of readiness tool that includes descriptions of goals and room for self-assessment. This tool prompts administrators to assess where they are in relation to the goal and reflect on progress. It also includes a series of open-ended questions designed for reflection (AZ DOE, 2015). Instead of prescribing the steps to take to achieve the recommendation, this type of tool allows administrators to independently determine what needs to be done to alter their "current reality" to prepare for an implementation.

3.3.4 Team-based needs assessments

Some needs assessments include a component for assessing gaps between a leadership team's skills and abilities and the skills necessary for a successful implementation. There are also needs assessments that solely focus on the knowledge and abilities of the team, leaving the infrastructure elements up to the team to determine. This type of tool puts emphasis on the team's knowledge and skills instead of the school's structures and programs. Alliance For Excellent Education's District Assessment is one such tool (Alliance For Excellent Education, 2015). Rather than reflect on school structures, it prompts leaders to focus on their own knowledge and abilities to discuss and strategize for challenges relevant to implementing a 1:1 program.

3.3.5 Prescriptive rubrics

Fully prescriptive rubrics are designed to allow leaders to determine how close they are to an ideal level of readiness and what they need to do in order to further improve towards full readiness for successful implementation. These can vary in how much detail is provided at the different levels of the rubric, but there is generally enough detail that leaders know what steps need to be taken in order to get to the next level. The ProjectRED Readiness Tool and Calculator is an example of a fully prescriptive rubric (ProjectRED, 2012)

One unique function of the ProjectRED Readiness Tool is the scoring mechanism. Instead of suggesting that schools aim for the highest level of readiness, the scoring function allows leaders to see where they should allocate the most resources. For example, if the instructional support score is low but the technical infrastructure score is high, the rubric suggests that the school think about allocating resources to instructional supports for technology before improving upon the infrastructure. This provides a useful way for leadership teams to think about resource allocation in striving to be as ready as possible for an implementation.

3.3.6 Open-ended questionnaire and consultant support

Though very different from the options previously presented, there are a number of education consulting organizations that provide support services for technology implementation. These services can begin with a questionnaire, which serves as a needs assessment for the school and the basis of future meetings and conversations with a consultant. This option is more cost-intensive than the others, however, it provides the distinct benefit of individual support and guidance, which some schools may find that they need during this complex and time-consuming process.

One group that does this type of consultation is Education Collaborators, a group of experienced technology directors who put their knowledge to use for other school districts. When a school contacts them for assistance, they first provide a lengthy questionnaire considering the school's technical infrastructure, current support services, and plan for the future technology implementation. Based off of these answers, the school has a follow-up call with a consultant.

Together, the school leaders and the consultant decide what will be the best method of support for the school (Alex Inman, personal communication, January 21, 2015).

Chapter 4: Methods

This methodology section begins with a general outline of the case study approach and is then split into two sections to represent the two different lines of inquiry used to answer the proposed research questions. The first section identifies the methods used to determine a set of critical metrics for measuring readiness for technology and a sustainable implementation model for 1:1 programs. The second section identifies the methods used to evaluate the use of planning tools in implementation and school leaders' preferences for different varieties of such tools.

4.1 Case Study Approach

In order to determine a set of metrics to measure readiness and a model of the best practices for implementation, a case study approach was taken. Schools currently implementing 1:1 initiatives were contacted and asked if they would be interested in participating. This contact process was largely through personal knowledge of local schools implementing 1:1 programs, online searches for initiatives, and word of mouth.

In the second year, the Future Ready Schools (FRS) initiative, which includes a state-by-state listing of school districts where the superintendent of the district has taken a pledge to be future ready, was further underway and it provided a good resource for locating 1:1 schools throughout the country. Again, general online searches were utilized, but FRS was a useful resource in providing a list of self-identified "future ready" schools to contact.

4.2 Methodology for Creating a Readiness Rubric and Sustainable Implementation Model

The section describing the methodology for creating a readiness rubric and sustainable implementation model begins with an outline of the call for partners to participate in the study.

Then, the surveys and interviews utilized for data collection are described. Finally, the coding and analysis processes are examined to shed light on how results were determined.

4.2.1 Call for partners

Cooperating schools and educational partners were essential to the project to ensure a collection of data about the current large-scale implementations in real time. In order to study these projects, the following partners from 1:1 schools were sought:

- District and School Administrators: To give an overview of the program and goals of their respective schools and districts in the context of new educational technologies and initiatives.

- District and School IT Specialists: To give specific information on technical capabilities and specifications of devices at schools, as well as insight into technical problems that occurred during implementation.

- Classroom Teachers: To give first hand insight into the use and implications of the new hardware in their classrooms.

Generally, the search for partners began by contacting the principal or superintendent. From there, school leaders who chose to participate were able to send information to their staff members about participating through surveys and interviews.

4.2.2 School characteristics

As shown in Table 1 below, most schools are implementing 1:1 iPad initiatives in which the school provides the devices to the students. For a comparison, there is also a school that uses Chromebooks and a school that has students bring their own iPads (BYOD) to school (this school allows students to bring any type of iPad – including an iPad mini).

Table 1. School Characteristics*

School	Type	Student Population*	% low SES*	Type of 1:1	Start of implementation**	State
Bedford	Public	902	12.7	iPad	2011	MA
Burlington	Public	1,135	10.8	iPad	2011	MA
Franklin Academy	Charter	366	0	iPad	2010	NC
Red Bank	Public	827	58	Chromebook	2013	TN
Revere	Public	1,559	74.9	iPad	2012	MA
St. Dominic's	Private	748	2	iPad – BYOD	2013	MO

*School characteristics in student population and % low SES (socio-economic status) reflect numbers reported by the respective state department of education (where they could be found) for the 2012-2013 school year. Where numbers were not published, an average of teacher and administrator responses was used.
**Generally, the start of implementation occurred in the start of the school year, in August or September of the given year.

4.2.3 Surveys

Two surveys were created and administered to gather information from the IT department, teachers, and administrators. The IT survey focused on the technical aspects of the implementation and the devices, while the teacher and administrator survey focused on school characteristics and curriculum aspects of the technology. The goal of the surveys was to gather basic data about the initiatives from staff members and draw initial trends and differences both between and within schools. The categories for each of the surveys are presented in Table 2 below:

Table 2. Survey Categories

Teacher & Administrator	IT Staff
• School Information	• School Information
• Tech Standards & Initiatives	• Tech Standards & Initiatives
• Support Problems	• Support Problems
• Technology Access	• Network Specifications
	• Device Specifications

The specific questions for the surveys can be found in Appendix B and were closely modeled off of an education technology readiness survey known as the Smarter Balanced

Technology Readiness Tool (TRT). This tool was created in association with the Partnership for Assessment of Readiness for College and Careers (PARCC) to aid school districts in the transition to online assessments. The instructions in the survey indicated that all questions were optional, so if a respondent was unsure of an answer or did not have an opinion, he or she had the option to leave the question unanswered.

After schools were chosen and contacted, administrators sent out the survey to teachers and staff members, presenting it as an optional way to get involved with a research initiative about education technology. Over 75 responses were collected in total (70 of which were from teachers and administrators and the remaining from IT staff). Each school was represented, with multiple staff members from every school responding to the survey. All responses were collected online through a survey service and automatically compiled into a summary document. The surveys were anonymous (the only identifying data collected was a question that asked the respondent to describe their position in the school (i.e. administrator, teacher, technology department, etc.).

Aside from basic data used to fill out demographics and detail on the initiatives present at the school (which were then expanded upon in the interviews), the survey for the teachers and administrators asked participants to rate teachers' comfort level with technology and the amount of support and training given to teachers on a scale of 1-6. The number of options was intentionally an even number in order to prompt participants to pick a side on the issue (as opposed to choosing the middle option in indifference). The survey also asked about types of technology utilized in the classroom and around the school, as well about technology staff available to address technology concerns and problems.

The survey for IT staff asked for similar information to the teacher and administrator survey on the use of technology at the school in terms of equipment available, student access, and technology standards. It also addressed the potential problems of teacher training and support through a similar set of rating scale questions. In addition to these similar questions, the IT survey asked participants to identify the device specifications for the device selected for use in the 1:1, as well as network specifications in terms of bandwidth, access points, and network speed. This information was used to classify initiatives by type and was used in conjunction with interviews to determine where gaps for schools may be present.

4.2.4 Interviews

The final question in the survey provided an option for respondents to leave their email addresses if they would like to speak further on the topic of 1:1 at their schools. These people were then contacted to arrange an interview. Further interviews were also arranged through the principal with teachers who had strong feelings on or engagement with the technology initiative. Interviews were done in person at the three local schools in Massachusetts and over the phone with the three out-of-state schools. All interviews were recorded on the author's computer and later transcribed and coded for data analysis purposes. At least one technology person was interviewed from each school (either a teacher or IT director who was very involved with the technical aspects of the program), as well as at least one non-technology teacher or administrator at each school. In sum, 15 individuals were interviewed.

The goal of conducting the interviews was to find out more about the specifics of each school's 1:1 program, especially the details of the planning and pilot phases, as well as the technical obstacles that the schools faced. These were semi-structured interviews and were used to gather targeted data from interviewees. Questions varied depending on the role of the interviewee in the school, and a full list of interview questions can be found in Appendix C. The data was compiled for each individual and then compared within and among schools, once again using the schools as the basis for the cases of comparison. The categories and codes used in analysis are included in Appendix D. During the analysis of the interviews, code frequencies were determined and trends were analyzed. Not only were differences between schools noted, but also differences between individuals at the same schools were of interest, providing examples of where staff members disagree or have different understandings of the same situation. Lastly, it is important to note that this is a small sample, and therefore, the data analysis looks to note differences and best practices, but cannot draw globally generalizable conclusions.

4.2.5 Coding and data analysis

Coding of the interview transcripts was done through a Grounded Theory approach. While carefully reading the transcripts, the author inductively developed codes in an open coding process. Because the author also conducted the interviews, it is likely that ideas for some codes

were developed a priori, but as much as possible, the codes were exclusively derived from the interview text.

After open coding all of the interview transcripts, axial coding was done. In axial coding, the codes used from the open coding process were related to one another and grouped into categories. These axial codes describe the more general topic being addressed by a set of codes and relating to the research question at hand. Lastly, all of the data was grouped into selective codes, which serve as the core category for the data and largely drive the conclusions and results found through the research.

Analysis of the data was done both inductively and deductively through considering the results from the survey, interviews, and research and literature that already exists on the topic of technology implementation in education. Specifically, the barriers to implementation were considered in the context of the results from this research and analyzed to produce results specific to 1:1 programs, including the readiness rubric and sustainable implementation model. Further description of the analysis and results can be found in the following chapter.

4.3 Methodology for Evaluating Use and Merits of Planning Tools

A similar case study approach was taken to determine school leaders' use of planning tools and their opinions on the efficacy of a variety of planning tools. In total, 10 school leaders were interviewed. Three of these interviews were with participants who had given interviews on the topics of the first part of this research. Seven of the interviews were with school leaders who had not participated in the first part of the research. All 10 interviews were with leaders from separate schools. A description of the characteristics of these school leaders can be found in Table 3.

School leaders were found in largely the same manner in this phase as in the initial round of interviews. Aside from the original contacts, new contacts were found by Google searches for 1:1 schools and using sites such as Future Ready Schools where lists of technology-savvy schools are aggregated. The school leaders from the seven new schools that were interviewed (that did not take part in the initial interviews) were seven of 20 who were contacted with a request to participate. The 13 school leaders contacted who chose not to participate either did not

respond after an initial request and a follow up email or responded that they receive too many requests for information on 1:1 programs and therefore, cannot participate.

4.3.1 Call for partners

This call for partners was much less formal than the original call for partners in studying the readiness metrics. The communication consisted of an email explaining prior work and the need for additional research. Along with a request for a 30-minute interview, the previous paper completed on readiness metrics was attached to better illustrate prior work. If a leader did not reply to the initial email, a second email was sent about two weeks later. If the second email was not returned, there were no further follow-ups.

4.3.2 School characteristics

Table 3. Characteristics of School Leaders

School	State	Position	Previously Involved	Device	Start of Implementation*
Archbishop Williams	MA	Director of Technology	No	iPad	2012
Battle	MO	Media Specialist	No	iPad	2013
Bedford	MA	Principal	Yes	iPad	2011
Burlington	MA	Director of Technology	Yes	iPad	2011
Dedham	MA	Assistant Principal (former)	No	iPad	2011
Franklin Academy	NC	Principal	Yes	iPad	2010
Jefferson	CO	Assistant Principal	No	iPad	2013
Uxbridge	MA	Principal	No	iPad	2013
Wayzata	MN	Director of Teaching and Learning	No	iPad	2013
Whitnall	WI	Director of Technology	No	iPad	2014

*Generally, the start of implementation occurred in the start of the school year, in August or September of the given year.

Schools varied on who is involved with the technology leadership team. In each case, the apparent leaders of technology were initially contacted (if it was obvious from the school's website), and sometimes directed the author to another technology leader. In cases where it was not evident from the school's website who served as a leader of technology, the principal was contacted. Generally, the principal served as a technology leader, but sometimes they directed to someone else.

All schools contacted were high schools, serving at least grades 9-12, and in some cases, grades 7 and 8 as well.

4.3.3 Interviews

A similar interview format was used to conduct the interviews on planning tools. The author constructed a list of interview questions, which can be found in Appendix E and utilized a semi-structured interview approach with participants. For a portion of the interview, participants were asked to refer to a PDF that had been sent via email when the interview was confirmed. This document contained three examples of planning tools often used by school leaders in 1:1 programs. (This document can be found in Appendix F). A portion from the "infrastructure" section of each of the planning tools was used so as to show a representative section and to not overwhelm participants with the entire tool, which is often many pages long. The three planning tools that were sent were designed to be representative of the broader categories of thorough needs assessments that exist and are detailed in the results section.

Interviews were conducted via phone for all school leaders. Using the speakerphone and the recording device on the author's computer, the audio of all interviews was recorded. The audio recordings were all then transcribed.

4.3.4 Coding and data analysis

After interviews were transcribed, they were coded using a Grounded Theory approach by the same method described previously to code the initial interviews. To simplify analysis, the pieces of the interview that referenced different research questions were separated. For example, the codes used during the part of the interview that referenced an ideal planning tool for school

leaders were separated from the codes used during the part of the interview in which school leaders compared different needs assessments. Then open, axial, and selected coding were utilized in order to later analyze the data. The analysis is described further in the following chapters, and all codes can be found in the analysis done in Chapter 7.

Chapter 5: Analysis I: Best Practices for 1:1 Implementation

Through the analysis of the survey and interview data, many trends could be identified in terms of infrastructure, planning, and support. The infrastructure issues that were most frequently cited included teacher-reported issues, access points, bandwidth, network, management, and device set up. Teachers often reported physical damage and some issues with the network, which caused problems for students utilizing the technology in class. Obtaining sufficient bandwidth and an adequate number of access points were important concerns for all schools. Schools had varying opinions on how to protect the network, but regardless of approach, the network restrictions posed a challenge. Central, streamlined management of devices was a point of emphasis for a number of technology directors.

All schools participated in a planning phase for the 1:1 initiative that included a pilot and testing different devices. Pilots included testing carts of devices or a 1:1 program with a subset of the school population (usually a single grade level or a group of classes). Most schools utilized committees including a group of diverse stakeholders and led by a senior administrator in the district. Some schools forged relationships with "mentor" 1:1 schools to walk them through the process. Budget construction varied widely among schools, as did processes for acquiring additional resources for teachers and students.

Interviewees reported that a number of technical and social needs of teachers needed to be met to ensure a successful implementation. Teachers need to be involved in the planning phases and receive high quality professional development on using technology. Because teachers have widely varying skill levels in using technology at the outset of a program, many noted that it is important to provide substantial technical support and resources to teachers to aid them in learning best practices for technology use in the classroom.

Below, these trends in infrastructure, planning, and support are identified and explained in relation to the data and where applicable, related to the existing research and literature on education technology.

5.1 Infrastructure: Technology readiness

Though all of the schools in the sample had a solid infrastructure in place at the start of the 1:1 programs, as evidenced by the ability for all students to use their devices daily and the absence of large network outages (100% of schools reported that the network had not gone down for more than a short period of time since the 1:1 program began), teachers still reported many common technology problems.

5.1.1 Teacher-reported issues

To give an idea of the types of infrastructure problems that the teachers and staff at a 1:1 school often run into, the most common responses will be outlined. In terms of physical damage, over 50% of the teachers whose students have iPads mentioned that there are many students with cracked screens and physical damage (while the teachers who work at the Chromebook school only mentioned slight discoloration problems, but no serious physical damage). Software problems include issues with apps (83% of teachers note at least occasional problems with apps functioning correctly) and syncing upgrades correctly throughout the school (one teacher mentioned that when students update before they are supposed to, software doesn't sync properly).

In relation to network and Internet issues, 50% of the teachers interviewed noted the difficulty in adapting lesson plans when there are network failures and they are unable to use the devices as planned. One teacher even noted that the devices have the ability to "turn good lessons bad", as a good lesson that relies on technology can turn into a problem when the technology fails.

One other important discrepancy that came out in speaking with the teachers is the differences in perception between teachers on how well the technology works. At one school, teachers had wildly different views on how many problems there are with access and using the devices. Specifically, one teacher noted that there were "no large issues", while another reported that there were "issues daily". Though these teachers are likely encountering many of the same troubles, as they share a school network, it could be that the strength of the connection

throughout the school varies or that expectations of how well the technology should function differ among teachers.

5.1.2 Access points

All buildings have at least one access point for every other classroom, and half have one for every classroom. None of the schools reported problems with spotty Internet access (in terms of not being able to connect in certain classrooms), although one administrator did mention that they do not yet have enough access points in the gym for the connection to be strong throughout the entire area.

5.1.3 Bandwidth

Bandwidth varied quite a bit from one district to another, especially in relation to the school's population and size of the 1:1 program. One technology director noted that a school should get as much bandwidth as is possible and affordable. This particular district had one 400 Mbps line and two 75 Mbps lines for failover and redundancy. He also noted that 400 Mbps was the best that they could get (and afford) being about 15-20 miles outside of a major city. Another technology director said that with an additional 500 computers and 200 iPads coming into the system next year, they are looking to further upgrade the district's bandwidth to 500 Mbps very soon and then to 1 Gbps within the next year. Though the relationship between location and bandwidth availability was not explicitly discussed, the district planning to upgrade to 1 Gbps was the district that was closest to a major city, about 5 miles outside of Boston. On the other side of the spectrum was a more rural district that shared a 50 Mbps line between three schools (including 25 Mbps at the high school, where the 1:1 initiative was). The technology director in this district noted that this situation was inadequate for the programs and the structure of sharing a line via fiberlink between schools was seriously flawed. They planned to upgrade shortly.

5.1.4 Network

Protecting the network is something that all of the schools have considered, though they have come to different conclusions on how to do it and what to allow for students and teachers. The responses ranged from an entirely open network (with the exception of blocking sites that would be deemed illegal to be open in school, such as pornography) to blocking all social media and limiting app downloads. First, the technology director of the district that leaves the network largely open noted that they do not want to make stringent rules and blocks on the network only for a few kids who misbehave. Instead, the network is left open as there are both good and bad uses of many sites, and the good outweigh the bad.

Other schools only block selected popular social media sites, such as Facebook or Twitter; there did not seem to be a standard among all of the districts for which sites to block or allow. One teacher said that YouTube had been blocked previously, but many teachers complained (as they use it frequently for showing videos to classes), and it was reopened on the network.

Lastly, sometimes schools put regulations on allowing students to download apps. Two districts mentioned such regulations that have been put on the students' devices. In one school, students cannot download apps at all; the school supplies and loads every app on their devices. In another district, sophomores, juniors, and seniors are allowed to download apps, but freshmen are not. Network and app regulations were an area of focus for all schools, yet there were not any central conclusions that could be drawn save for the need to consider which rules to put in place.

5.1.5 Centralized management

A centralized management structure was something that was cited as important (without specific prompting of the topic) by 50% of the technology directors interviewed. One technology director mentioned the need for streamlining in four separate comments and was supportive of the fact that the entire school district and town uses Google. In fact, that district has denied teachers' requests for using Microsoft Office products, as they want all teachers to be on the same page in using Google docs, presentations, and other Google applications. The principal in another district said that all students and their families would be receiving family Gmail accounts

in the following year in order to aid in streamlining and communication with parents. Lastly, a technology director from a third district stressed the importance of centralized management because of the need to make changes to the devices or software. He stated that a centralized system was especially important in terms of altering or updating devices and their contents.

One aspect of a centralized management structure is providing email accounts to all students. All districts provided email accounts to students who were in the 1:1 program, and teachers were well aware of the fact that all students have accounts. Specifically, two schools noted that Google was their learning management tool, and that every student has a Gmail account.

5.1.6 Setting up devices

Schools have the option of how much control over the devices and apps to retain and how much independence to give to students. One option that at least one district uses is "supervising" the devices, which gives the administrators much more control, but also causes bugs with updates; one teacher made two separate comments on problems with updates and supervised devices she has encountered with her students.

Mobile device management is another aspect of how the devices are set up. This management system is generally used for managing apps and e-books on the devices. In the BYOD school, there is not an option for mobile device management; the kids own their devices and the apps and e-books that are given to them are theirs to keep and cannot be transferred between students. In schools where the devices are supplied to students, management systems are used. One district uses Morachi Systems Management, a system to help with moving app codes between students to easily provide access to only the students who need the apps in a given semester. Similarly, this school also noted that Apple now has a time system for apps, in which students are set up to use the app for a certain amount of time before their "lease" ends and the app is transferred either back to the school or another student. At the end of this time frame, Apple provides the option for the student to buy the app to keep it; otherwise, it leaves the student's device. These types of app management systems help make sure that schools do not "burn through apps" as they would if they had to continually purchase them for each student each year.

Multiple teachers mentioned the ease with which app codes are transferred between students. They noted that students usually only need a particular app for a class or subject, and then they do not need it anymore. One technology director mentioned the usefulness of the Apple time window system and money-saving benefits to the mobile device management on multiple occasions his interview.

5.2 Planning and Pilot

All schools did some type of pilot with their devices before distributing them to all students in the school. These pilots included carts that teachers could reserve and use for a class period or more (two districts) and starting with a single grade or group of teachers and then expanding to other grade levels within one or more years (four districts).

5.2.1 iPad carts

Two schools did an initial pilot with an iPad cart that was very successful, and they both decided to expand to 1:1 after the cart trial period. One technology director made a few comments about the success of the cart and their decision to go to 1:1 with the iPad (as opposed to other devices). The factors that made the iPad more favorable to this school (as opposed to its competitor tablets and netbooks in 2010) were its operating system, battery life, and ease of input.

5.2.2 Starting small and expanding

Three schools started with a single grade and then expanded the program to the other grades in one or more years (while one school is currently in its first year with a single grade and may expand the program soon). One teacher and one administrator (from separate schools) expressed their disappointment with a pilot that starts with one grade and then builds to another. The teacher cited frustration with mixed classes that are “awkward” because some students have devices and some do not. The administrator noted frustration because the mixed classes are not a good incentive for teachers to use the devices in class. Both expressed a desire for the entire school to have started at the same time together with the devices.

Other teachers involved in a 1:1 initiative that started with just one grade did not express similar concerns about mixed classes and awkwardness. However, these teachers may have a different composition of students in their classes (some with entirely one grade, and some very mixed among grade levels), so it is possible that it would not impact some teachers as much as others.

5.2.3 Committee planning

Every school formed a committee or team to begin the 1:1 program planning, often including administrators, technology staff, parents, teachers, and students. One principal noted that teachers were not as involved in the planning process as (he thought) they should be, and there had been some resistance to implementation in the last few years because of this. At least two schools included both parents and students in their planning processes, and sought input from many different stakeholders, which they viewed as important. In all schools, the principal was very involved in the planning process, and in all but one school, a technology director was also very involved.

5.2.4 Modeling after other 1:1 schools

Looking to other 1:1 programs was essential in the set up of at least 50% of the schools. Three administrators commented that they modeled their programs off of other successful 1:1 programs. These three schools made an effort to visit other 1:1 schools and build relationships with the teachers and administrators there. One principal commented,

> *"We followed some schools that had already gone before us, watched what they did, talked to them a lot- schools across the country. We handpicked; they were similar to what we were doing and we think that was really helpful too. We got a lot of advice. At one point, based on the advice that we had received from one of the schools, we were able to purchase a set of 25 iPads that then began to be checked out by teachers… and that was a very good move."*

Other schools had similar sentiments about modeling their programs after another 1:1 program and the help they received from the other schools that were more experienced. Sometimes, these relationships were in person, and the committees visited the school, and other times, the relationships were digital and communication took place online. As the same principal (from the quote above) noted,

> *"We became friends even on the Internet with a number of schools across the country, that again, we've continued to have relationships with. That was key for us, building relationships with schools a year ahead of us."*

Therefore, regardless of the type of relationship that was built with other 1:1 schools, forging these relationships and partnerships was important in learning successful methods of implementation.

5.2.5 Testing of devices

Three teachers and administrators mentioned testing multiple devices before settling on one for their 1:1 programs. All of these schools were iPad schools. One technology director noted that they were looking at specific features of the devices while testing, and this helped them come to a final decision on which device to choose.

5.2.6 Drivers of implementation

All schools interviewed noted that the principal was one of the main decision makers in the initiative. Nearly 50% of teachers and administrators noted the importance of the superintendent and administration being supportive of the initiative. Two noted that the superintendent was the main driving force behind the program and one noted that the principal took the lead. Similarly, one technology director cited the importance of a top-down management structure in multiple comments and focused on the idea that the academic administrators and the superintendent of the district need to be on board with the initiative in order to have success.

One other interesting comment made by two technology directors was that in order for the 1:1 to succeed, the technology staff needs to be able to go above and beyond their current job descriptions. One director noted that he regularly goes into classrooms to help out teachers and students, which is something he was not responsible for doing before the initiative began. He also noted a similar willingness from his colleagues in putting forth the extra effort to make a 1:1 initiative work.

5.2.7 Construction of budget

The way the budgets of the 1:1 schools were structured varied. The major differences were where the funding was coming from and where the technology item was placed in the budget. It is important to note that all schools said that their funding was internal, and external grants were not a source of funding for the programs. They all felt strongly that the budgets should be restructured internally for sustainability.

One school noted that the budget for the 1:1 program was housed under operational expenses in the overall budget. The principal of this school said that by putting it in the operational expenses category, it occurs yearly, as opposed to in the capital expenses budget, which is more often used for large one-time purchases. He agreed with this expense placement, as he said it alleviates the need to reconvince the school committee year after year to continue funding the program. Other schools did not note where in the budget the technology expense lay.

When discussing the financing structure, three schools noted that the devices are leased. In these leases, a portion of the cost is paid each year and new leases are taken out as a new class of students receives the devices. There were a few different types of leases, including an equity lease from Apple and also a lease through the state for technology. Depending on the type of lease, the devices either needed to be returned when the lease was up or could be bought out by students (a student could choose to buy the device upon graduation for a large discount from the purchase price).

For the schools that did not lease the devices, but purchased them for students, there were a few schools that mentioned old devices being moved to the younger grades. A couple of schools had iPad carts that had been created with older devices at the younger grade levels. One

technology director commented that they are trying to determine the life of the iPad, and so far, they are at four years and counting.

One peculiarity in funding was at the charter school. At this school, the technology funding comes from the philanthropic arm of the founder's company. The technology director viewed this as a sustainable source of funding, but did note that when big purchases in technology need to be made (books, apps, etc.) the teacher or director who is requesting them needs to make a case to the school's founder for additional funding and then prove that they have spent those funds responsibly.

5.2.8 Other resources

Another large expense for some of the schools was app and e-book purchases. Though 5 of 6 schools noted that they mainly look to use free apps and books, all schools were also willing to consider other resource purchases at the request of teachers. Two technology directors noted that they participate in a Volume Purchase Program (VPP), which gives a 50% discount on certain apps (app developers choose whether or not to participate in the VPP). Two technology directors also mentioned the costly nature of e-books. They commented that there is not a discount on e-books, and therefore, there are not significant cost savings through purchasing e-books instead of regular textbooks.

Most interviewees mentioned that there have been trade-offs at their schools in order to finance the program. Three people said cutting down on printing and/or paper has saved money in the budget, and having a lot of printers is no longer necessary, as students can save documents and easily keep them on their devices. In nearly 70% of interviews, it was mentioned that no new textbooks are purchased at their school, which saves considerable funds that can go towards technology. One teacher reported that their previous textbook budget now goes to apps.

5.3 Technical and Social Needs of Teachers

With well-equipped and supported teachers, students are bound to have more success in the classroom. The most common barriers to using technology in the classroom for teachers according to the literature are a lack of confidence and a lack of training (Becta, 2004). These are

also commonly related to the needs that teachers expressed in their interviews and surveys. Specifically, planning structures and professional development were commonly noted as essential to teachers.

5.3.1 Planning

During the planning phase, it is important for teachers to be involved, according to administrators. All administrators that included teachers on a planning committee (4 of 6 schools had committees including teachers) note that it was important to include a teacher perspective. One school reported struggling with the iPads at first because there was not a lot of focus or support for teachers. However, when working with teachers became a focus, more teachers were able to successfully implement and start using technology in their classrooms consistently.

Giving teachers time to adjust to the iPads and to learn how they work is essential to a successful 1:1 initiative according to many administrators. In schools where teachers received the devices at least a few months prior to students, teachers reported being more comfortable when the time came to implement with students. On the other hand, some administrators who gave teachers and students the devices at the same time report that they regret that decision, as the teachers were not well-prepared to use them in the classroom and had to learn while managing a classroom and planning lessons in a 1:1 environment.

5.3.2 Professional development

Because teachers are often unfamiliar with the uses of an iPad, particularly education software and apps, it is important that they receive adequate professional development. Teachers report that the most useful development sessions allow teachers to work together to come up with ideas and solutions using technology. Half of the schools in the study reported that an increase in technology-based collaborative time for teachers was associated with increased feelings of competence with the devices and overall success in the initiative. The professional development opportunities can also give teachers the chance to engage in new pedagogy, and learn how to teach “in a different way”, as noted in the comment from a principal below:

"(What) we're seeing is just amazing things, amazing. It is a new pedagogy for teachers, as they learn to teach not just with (the device) as a fancy projector… not just a quick laptop, but really learning to teach in a different way … we're learning to be patient with that process, not to think that the first year a teacher experiences it, is going to have it down, because they're just not and I think you need to be real about that, and we're learning that."

The principal quoted above clearly understands the need for consistent support for teachers, as the adjustment process is not simple and quick, but instead takes much time and patience on the part of both administrators and teachers.

All schools have had some type of professional development with the devices, but the quantity and quality differ. One principal described the types of professional development that took place at the beginning of their 1:1 initiative: five curriculum support days hosted by Apple, sending teachers to other 1:1 schools to observe, and cutting down course loads for three of the most "tech-savvy" teachers in order to give them extra time during the day to stay ahead of the technology curve and assist other teachers. She noted that though these supports are expensive for the school, she views them as worthwhile, as they helped (and continue to help) teachers with problems they have encountered with the technology.

A teacher in another school spoke about the changes that the professional development has undergone in his school. Originally, he felt the professional development was of a high quality, and it seemed as if everyone was working together to share best practices and come to collaborative solutions. However, he noted that this type of professional development has dwindled and most sessions now have a presentation-like atmosphere and focus on presenting "solutions" to problems (generally apps that an administrator or technology director finds valuable), which tend to be replaced by the next best thing just a few months down the line. One example of a comment he made in regards to professional development is,

"So I feel like there's been a little bit of a shift from we're all in this together to here's what you need to do and here's .. yeah, here's what you're doing wrong."

He noted in multiple comments that the collaboration was much more valuable than the presentations on apps and technology, and that he would prefer the school goes back to the former style of professional development.

Even within a school, it varies greatly how much the teachers *feel* supported. For example, one teacher said:

> *"I feel like it's trial by fire. All of these iPads went out and it was expected that we would learn quickly, that we would use it every day, but no, I've never been to a seminar where they say, this is what you should do, these are apps that are useful. No one has ever done that. The only thing they told us is you will use edmodo. Period. So we know how to do that."*

Another teacher at the **same school** reported:

> *"The school itself is very big on professional development, most of it is focused on the iPad, although like I said, most of the time if we're going to a conference, we're probably the ones who are teaching (others) how to use it."*

Clearly, the professional development is received (or perceived) differently among teachers, but it is also clear that teachers need to feel supported to utilize the technology effectively.

5.3.3 Technology support

All schools mentioned that there was technology support on site at least a few days a week. The support ranged from one school that had a full time technology support person who was a former Apple employee to schools that shared a part-time technology support person with other non-1:1 schools in the district. In the survey for teachers and administrators, questions were asked to determine how concerned they were about technology-related issues.

For example, survey respondents generally reported being more concerned with the teachers' level of technical understanding in comparison to their concern about their technology

directors' level of technical understanding. This illustrates that though respondents believe that their technology directors are competent in running the program, the teachers may not be adequately prepared to use the technology. In addition, another question asked for the level of concern about training for teachers and technology staff. All schools respondents expressed some concern about the amount of training for teachers and technology staff, however, this varied largely from school to school. This indicates that in most schools, more training would be beneficial and there is room for more support.

Some schools feel much more confident overall in the support and staff available to them. Particularly, one of the schools averaged very low responses in terms of level of concern about training, support, and knowledge, which indicates that this school feels that the technology support staff and training they receive is adequate. This school was the school with a former Apple employee at the helm of the initiative as the full time technology director. On the other hand, another school had much larger concerns on average about training and support. In this school, there is only a .5 (part-time) instructional technology specialist who works with teachers. These responses and trends indicate that the level of support for teachers from technology specialists is an area of general concern for 1:1 implementations.

5.3.4 Teacher impact

Technology implementations affect teachers in a large number of ways. The major categories of impact expressed by teachers in this study include classroom management, skill level, resources, and support.

Classroom management

The devices have presented many obstacles and challenges for teachers on a day-to-day basis, including classroom management problems. All teachers who mentioned classroom management problems (7) noted ways in which kids could be distracted from learning, including communication with each other through apps such as iMessage (3) and through games and other apps (2). Furthermore, many teachers mentioned multiple ways in which classroom management is more difficult, including the difficulty in monitoring usage (4) and a hard time combating

cheating through communication on iPads (1). A few teachers cited distraction as the biggest problem that they face day-to-day with the iPads.

Disparity in skill level

Another problem that schools encounter is that not all teachers have the same amount of experience and comfort with technology. Oftentimes, the younger teachers will have a higher level of comfort with technology, as they have used it for most of their lives, while the older teachers have not. Three of the teachers commented that disparity in skill level and comfort among teachers was a problem with the start of the 1:1 initiative. Two teachers said it is difficult for teachers to adjust to the use of technology as they are "stuck in their ways", while another teacher even noted that some of the older teachers at his school retired early with the issue of the iPads.

Resources

Resources proved to be both a blessing and a curse for teachers. On one hand, five teachers said they were excited for kids to have access to more resources through technology. On the other hand, a couple of teachers noted that an abundance of options has also caused problems. One problem is when apps are not streamlined; in this case, all of the teachers use different apps, and this creates confusion among the students. One school cut down options for teachers during the pilot year in order to cause less confusion for students who were constantly switching between apps for different classes. Another school reported that they currently load their iPads with 70+ apps for students and teachers at the beginning of the year because they have never removed apps requested or selected in previous years; they are hoping to cut down on that number in the coming year.

To streamline the workflow for students, three schools mentioned that school-wide apps are selected, but that teachers can also make app requests and they will buy specific apps for teachers (for example, graphing calculators). Common apps that teachers and administrators mentioned were Edmodo (widely used in 5 schools) and Schoology (widely used in 2 schools). Both Edmodo and Schoology are free. Two people said their school constantly asks teachers to adopt new and exciting apps, and the rapid switches between these apps is a problem. Three

noted that a strength of their school lies in teachers building their own books and content online. At least two schools buy e-books for some subjects.

Teachers helping teachers

Two schools mentioned that they have instituted some form of teacher-to-teacher assistance. In one school, there is a Google doc where teachers can look for help with certain apps or other iPad-related issues by seeing the other teachers that have signed up to help with that specific problem. In another school, there are "tech teachers" who have a lessened class load in order to spend more time in other classrooms helping out teachers with technology issues in the building.

Four schools have support through a group of students, known as the "iSquad" or "genius bar", among other titles. This gives students an opportunity to delve into the technology further and also gives teachers another place to get support. Another school said that they hosted a "tech showcase" in which students showed teachers how to use their favorite educational apps.

Chapter 6: Readiness Results: Rubric and Sustainable Implementation Model

Based on the data collected, a readiness rubric and a sustainable implementation model were created. These products are designed to aid school administrators in their preparation for implementing a 1:1 program.

6.1 Readiness Rubric

The metrics developed to aid school administrators in planning for 1:1 programs were compiled into a readiness rubric. *This rubric is an essential part of the report and can be found in Appendix A.* The rubric covers tech, school, and teacher readiness across a number of metrics and categories. The metrics are qualitatively described by the categories of 'Needs Improvement', 'Satisfactory', 'Good', and 'Excellent'. The rubric is designed for each metric to be assessed for readiness separately. For each metric, the categories represent the following spectrum of readiness levels:

- **Excellent**: The school is ready for implementation.
- **Good**: The school could succeed with implementation.
- **Satisfactory**: The school could implement, but there would be problems associated with this gap in readiness.
- **Needs Improvement:** The school should not implement until this gap has been addressed.

A school would likely find itself to have varying levels of readiness across the categories and metrics of the rubric. In this case, the rubric is intended to help school leaders determine where their time, effort, and resources should be focused in order to improve before implementation.

The metrics and categorization of different states of readiness according to those metrics were developed through the analysis of reports from the 1:1 schools studied here. Some technical details were added through the literature (ex. numbers for bandwidth). These results are based on the best practices from the small sample of schools studied, and may not be generalizable to

other contexts, especially outside of the United States. However, they do represent a useful framework for administrators considering implementing a 1:1 initiative in their schools, and provide a way to think about the structures and supports that would likely lead to success.

6.2 Sustainable Implementation Model

Based on the rubric, a sustainable implementation model was generated. This model focuses on the very best practices of schools studied and suggests a way of implementing and structuring a 1:1 program in a sustainable manner in terms of technical infrastructure, financing, and teacher support systems. Below the categories of implementation and their best practices are described.

6.2.1 Technical infrastructure

Technical infrastructure is essential to a successful 1:1 program, and can be regarded in terms of both physical infrastructure and management. The following guidelines represent some of the most important aspects of these categories.

For the physical infrastructure, the main concerns are bandwidth, access points, and the network. Because bandwidth needs quantitatively vary from school to school (depending on the total number of devices, students, teachers, and staff), the best practice is that qualitatively, the school should be able to support all content creation activities through their wireless network, with some excess capacity for adding additional devices. The State Educational Technology Directors' Association recommends that a school has 100Mbps for every 1000 students and staff members (Fox, 2012). To ensure the network covers the entire building, there should be an access point for every classroom, as well as multiple access points in the larger learning areas (such as the gym or library). Protecting the network will also vary by school, depending on the concerns of teachers and administrators, but access to sites should be well-monitored, evaluated, and updated as new needs of students and teachers arise.

Management of the devices and systems is an aspect especially important for sustainability of a 1:1 program, and includes device management systems, email, and repairs. With a large number of devices in the school, and many apps and software in use, it is important

to have a device management system where apps are school-owned and can be easily transferred between students. In addition, to aid communication, a best practice is for schools to give students, families, and teachers school-based email accounts. Lastly, it is common for devices to break, so to expedite repairs and ensure that students do not go long without devices, schools should insure all devices and handle repairs.

6.2.2 School financing and planning

On the school and administrative side, it is important that the plan for financing incorporates sustainability and that the planning phases adequately prepare teachers for a full implementation.

Schools can opt to either buy or lease devices, depending on what administrators feel comfortable with, but the funding should come from internal sources, and not outside grants. In order to fund the initiative, trade-offs need to be made. These trade-offs might include decreases in substitutes or cutting down on the number of computer labs. Regardless of the trade-offs that happen and how the budget is restructured, teachers and administrators need to work together to make joint decisions on the cuts and reallocations. Aside from purchasing the devices, it is important that a school incorporate insurance (or repair) costs, as well as app and software expenses into the budget. Schools should be flexible in taking teacher requests for software and apps, while also responding to teacher requests for other technologies.

Schools should consider their current budget structures and determine the most appropriate way to account for expenses between the operating and capital budgets. Generally, annual expenses would be put into an operating budget, and one-time infrastructure purchases into the capital budget. However, given the structure of device leases (an equal percentage of the cost is paid each year) and the need to consistently maintain infrastructure, the costs of technology do not necessarily fit neatly into one budget or another. Schools need to make a decision on how to expense their programs, though these decisions will vary depending on the school's circumstances and budget history.

As a school is preparing to begin a 1:1 program, there should be a committee with representation from different stakeholders (IT, teachers, parents, students, and the community) in place to help administrators with the planning process. Teachers should be well informed of the

benefits of the new technology and there should be excitement among the staff to get started with the initiative; this will aid teacher volunteerism in planning and general support of the program. Connections should be made with multiple 1:1 "mentor" schools. These schools should be visited and strong working relationships built. Lastly, it is important for different devices to be considered and tested before deciding on the device that all students and teachers will receive. It would also be wise to conduct a small pilot during the planning phase, including classes in various grade levels.

6.2.3 Teacher support

Without teachers on board and fully supported, there are bound to be serious problems with a 1:1 initiative. Strong systems and supports need to be put in place for teachers to make sure that they can use the technology in the best possible way and feel comfortable using the devices with students.

For general comfort with the devices, and to begin to learn how to use them in the classroom, teachers should receive the devices one year prior to students. During this year, teachers need to attend professional development in conjunction with the uses and benefits of the technology. This professional development should include not only how to use the device, but also focus on relevant apps and pedagogical practices. There should be time allowed during the training to work collaboratively and explore different use cases with their colleagues. Teachers should attend 5+ full days of professional development (or the equivalent) in association with new devices and technology over the course of this first year. When the full implementation begins, professional development should continue on a weekly or monthly basis, including collaborative time for teachers.

During the full implementation with students, teachers need to have support staff on site for when they have questions or run into obstacles. Industry standards recommend one full-time technology person to support every 500 machines (Tenbusch, 2011). In addition to full time staff members available for IT support on site, full time instructional technology support specialists are also necessary. It is important for teachers to support other teachers as well; a few teachers should have reduced class loads and serve as technology leads for the teaching staff. Students are another great source of support for teachers, and it is wise to have an identified team of students

(across grade levels) who provide technology support to teachers and other students; this could be in the form of a help desk or otherwise.

Lastly, teachers need to have access to resources. Teachers should have access to all of the resources they need, and upon finding additional resources they would like to use, the technology staff should update devices quickly to make these resources available (if necessary). In the longer term (likely not within the first year), there should be plans for teachers to create and revamp all of their materials digitally and create their own digital textbooks for school use.

Chapter 7: Analysis II: Use and Merits of Planning Tools

The second phase of this research analyzes school leaders' experiences in using planning tools to plan an iPad 1:1 implementation, as well as their preferences in relation to such tools. This data was entirely derived from a series of interviews conducted with principals, technology directors, and other specialists who were intimately involved in planning a 1:1 program. The results show that most school leaders did not use planning tools in their efforts to start a 1:1 initiative, most frequently because such tools were not available at the time of implementation. However, most schools did work with mentor schools to learn best practices for implementation. Of the many aspects of an ideal planning tool that were mentioned, teacher training and rollout were the two cited by nearly all school leaders, and therefore, would be most important to include in a planning tool. Lastly, school leaders did not come to a consensus on the best of the three planning tools presented in a comparison of different existing tools. The remainder of this chapter discusses the results of these interviews in more detail.

7.1 Use of Planning Tools

In the interviews, all participants were asked if they had used a "needs assessment, readiness rubric, or other similar planning tool" during implementation. Their responses are detailed in Table 4 below.

Table 4. Use of Planning Tools in 1:1 Implementation

School	Did they use a planning tool or needs assessment?	If yes, describe.	If no, was a reason given?
Archbishop Williams	No		No reason given.
Battle	No		Created tools internally.
Bedford	No		No reason given.
Burlington	No		Too early, none existed.
Dedham	Yes	Assessed infrastructure and staff needs in understanding and comfort in technology.	
Franklin Academy	No		Too early, none existed.
Jefferson	Yes	Open-ended assessment from tech team to tailor support.	
Uxbridge	No		No reason given.
Wayzata	Yes	Picked checklists and other tools based on their ability to help the school meet their mission and vision.	
Whitnall	No		Too early, none existed.

As can be seen from Table 4, only three of the ten school leaders reported using needs assessments or other similar planning tools during the planning phases of their 1:1 implementation. Of the seven that reported not using a planning tool, three said that such tools were not yet available because their implementation happened shortly after the iPad was introduced. The remaining four school leaders noted that they did not use a planning tool, but instead utilized other methods for planning. The other methods used for planning for all schools, along with other thoughts on the topic of planning tools and consultants, are described in Table 5 below.

Table 5. Other Methods Used for Planning

School	Methods used in planning	Other thoughts on planning tools and methods
Archbishop Williams	Literature; discussions with wireless providers; committee with teachers, parents, and alumni; PD through Apple; partnership with other Catholic schools for PD.	Consultant is not necessary.
Battle	Research on other 1:1 initiatives, devices, and funding options; meetings with teachers; advisory council.	
Bedford	Institutional knowledge; outside consulting firm for training school leaders.	Infrastructure planning was difficult initially.
Burlington	Visits to other 1:1 schools; collaboration with other schools; development of in-house PD based off of best practices applied to technology; materials from Apple created originally for the Maine 1:1 laptop program.	Checklist or guide would be useful; consultant is sometimes useful.
Dedham	**Planning tool/needs assessment.** Pilots; surveys; in-house discussions.	
Franklin Academy	Visits to other 1:1 schools; collaboration with other schools.	Apple has never been helpful; consultant is sometimes useful for larger scale programs.
Jefferson	**Planning tool/needs assessment.** Committee of teachers and specialists.	
Uxbridge	Collaboration with other 1:1 schools (depended largely on Burlington); internal tech knowledge.	Rubric would have been helpful.
Wayzata	**Planning tool/needs assessment.** Internal expertise; collaboration with other 1:1 schools; Apple consultant.	
Whitnall	Visits to other 1:1 schools; collaboration with other 1:1 schools; staff-only pilot program.	Written long-term plan would have been useful.

Table 5 shows that the most popular planning method for these schools was through collaboration with other 1:1 schools; seven schools collaborated with other 1:1 schools. In addition to collaboration, visits to other 1:1 schools were also fairly common, as three schools

reported that visiting other 1:1 schools was influential in planning. Internal knowledge, in-house discussions, or a committee were instrumental in planning for eight of the schools, though it is likely that internal knowledge played a part in planning for all of the schools as staff members took part in planning efforts in all schools. Lastly, materials or a consultant from Apple were helpful in planning for three of the schools. Interestingly, one school reported that Apple has never been helpful in assisting with planning or implementation in any way. Schools have mixed feelings on whether a consultant is useful in the process.

7.2 Ideal Planning Tool

During the interviews, school leaders were asked to describe what the ideal planning tool would include. There were not any additional (more specific) prompts for this question, as it was intended to be left open for participants to answer based on their experiences and needs. The list below in Table 6 describes all answers and their frequency for this question, in order from most frequently cited (teacher training) to least (a variety of aspects that were mentioned only once).

Table 6. Topics Covered by an Ideal Planning Tool

- Teacher Training (10)
- Rollout (9)
- Infrastructure (8)
- Bandwidth (8)
- Support for Teachers (6)
- Network (6)
- Device – management (6)
- Step by Step Guide (5)
- Digital Citizenship (5)
- Access Points (5)
- Technology Staff (4)
- Resources for Teachers (4)
- Device – choosing (4)
- App Purchasing (4)
- Student Training (3)
- Parent Education (3)
- Communication plan (3)
- Budget (3)
- iTunes Store (2)
- General needs assessment (2)
- Classroom Management (2)
- Assessment of Teacher Readiness (2)
- Administration (2)
- Vision (1)
- Vendors (1)
- Student Accounts (1)
- School Culture (1)
- Replacement (1)
- Priorities Checklist (1)
- Priming Questions (1)
- Power (1)
- Pilot (1)
- Learning Management System (1)
- Learning (1)
- Insurance (1)
- Family Readiness (1)
- Discipline (1)
- Consultant (1)
- Chart for bandwidth (1)
- Building flow (1)

These responses were then grouped into categories to summarize the data. The categories are technical, staff, logistics, and students and parents. Table 7 below shows the results grouped by category.

Table 7. Topics Covered by an Ideal Planning Tool – Grouped by Category

TECHNICAL	STAFF	LOGISTICS	STUDENTS & PARENTS
Bandwidth (8)	Teacher Training (10)	Roll out (9)	Digital Citizenship (5)
Infrastructure (8)	Support for Teachers (6)	Device-Mgmt (6)	Parent Education (3)
Network (6)	Resources for Teachers (4)	Step by Step Guide (5)	Student Training (3)
Access Points (5)	Technology Staff (4)	App Purchasing (4)	iTunes Store (2)
Building flow (1)	Administration (2)	Device- Choosing (4)	Discipline (1)
Chart for bandwidth (1)	Assess-Teacher Readiness (2)	Budget (3)	Family Readiness (1)
Learning Mgmt System (1)	Classroom Management (2)	Communication plan(3)	
Power (1)	Learning (1)	General needs assessment (2)	
	Priming Questions (1)	Consultant (1)	
	School Culture (1)	Insurance (1)	
	Vision (1)	Pilot (1)	
		Priorities Checklist (1)	
		Replacement (1)	
		Student Accounts (1)	
		Vendors (1)	

As can be seen in Table 7 above, technical aspects of planning were mentioned a total of 31 times, staff aspects were mentioned 34 times, logistics were mentioned 43 times, and students and parents were mentioned 15 times. There is the widest variety of responses concerning logistics and the least variety in students and parents.

7.3 Comparison of Existing Planning Tools

In the final segment of the interviews, participants were asked for their opinions on three distinct planning tools. The intention of this inquiry was to gather information on the benefits of structure and general aims of planning tools, as opposed to the metrics and content. For example, one of the tools presented gives school leaders the ability to assess their team's ability to discuss a certain topic and come to a conclusion. Another planning tool is a fully prescriptive rubric, where the self-assessment takes place by determining where the school is on a spectrum of readiness. The full document sent to participants can be found in Appendix F.

The document was composed of a small sample of each of the tools drawn from their respective "infrastructure" sections. This section was selected both for its straightforward nature (the language is easy to understand) and because all of the sample tools included an

infrastructure section, which is not the case for all sections. The author sent the document to the participants ahead of time and then described each planning tool during the call. There was also a description of the tool above it in the document, as can be seen in Appendix F.

Though the process for the selection of the tools and a description of their respective content were given, there was still some confusion among participants in regard to missing pieces of the tools. Specifically, a few participants asked why other aspects of planning were not included, or mentioned that it would be important for other aspects besides infrastructure to be included. At this point, the author re-clarified that these examples represented only a small subsection of the tool and that other topics were indeed covered by the tools when seen in their entirety, but not included in the document for sake of simplicity. Moreover, at times respondents focused heavily on the content of each of the metrics, as opposed to their general structure and aims. In these cases, the author redirected participants to think about how the tool is structured and its goals, as opposed to the wording of a single metric. The results from this comparison are described (by planning tool) in the following subsections.

7.3.1 Fully-prescriptive rubric

The first example tool participants were asked to review was the readiness rubric created by the author (which can be found in Appendix A). This represented a fully prescriptive rubric, which gives options for school leaders to choose from to identify their readiness level for a given metric. The aim of the rubric is for leaders to determine where their greatest needs lie and focus time and resources towards improvement in those areas. Also, though the author's rubric was used as an example, the ProjectRED Readiness Tool also resembles a fully prescriptive rubric that school leaders might utilize.

The codes from each section of the interviews were grouped into positive characteristics of the tool, negative characteristics of the tool, and uses of the tool. Table 8 shows the results for the fully prescriptive rubric by code and frequency.

Table 8. Responses for Fully Prescriptive Rubric

POSITIVE CHARACTERISTICS	NEGATIVE CHARACTERISTICS	USES
Detailed (3)	Low bar for "excellent" (2)	Assessment of readiness (6)
Useful (3)	Unclear delineation between levels (2)	
Descriptions are helpful (3)	Too vague (1)	
Easy to use (2)	Needs more detail (1)	
Structure is good (1)		
Concrete (1)		
Non-tech person could use (1)		
Accurate (1)		
Generalized (good) (1)		
Spectrum of instances is helpful (1)		

As can be seen above, the most commonly noted positive characteristics of the fully prescriptive rubric were its detail and given descriptions for each level of readiness. Others thought it was generally useful and easy to use. Negative characteristics cited by participants included that the bar for the "excellent" category of the rubric was too low and there was an unclear delineation between levels. Lastly, over half of the respondents noted that they would utilize the rubric to assess readiness for implementation at their schools.

7.3.2 Team-oriented needs assessment

The second planning tool participants were asked to review was a team-oriented needs assessment. This tool focuses on the abilities of a school leadership team to knowledgably discuss a given topic and come to the appropriate conclusion for the school. This tool did describe levels of readiness in terms of the team's ability to have a discussion, however, the descriptions did not vary from one topic to another. Instead, they were applied generally to each metric to measure team readiness. This planning tool is part of the Future Ready Schools District Assessment.

The responses for this rubric are grouped similarly to the first tool, in terms of positive and negative characteristics and uses of the assessment in Table 9 below.

Table 9. Responses for Team-oriented Needs Assessment

POSITIVE CHARACTERISTICS	NEGATIVE CHARACTERISTICS	USES
Team readiness is important (3)	Not useful (3)	Decision-making (2)
Most useful of three (2)	Too many words (3)	Knowledge gap assessment (1)
Harder topics are covered (1)	Not well organized (2)	Vision (1)
Easy to use (1)		

Participants were generally split on the team-oriented needs assessment. Some of the participants felt strongly that it was the most useful of the three rubrics and that covering team readiness was extremely important. However, others felt that it was not useful at all and its structure left something to be desired. Participants saw a wider variety of uses for this tool, noting that it could be used in the decision-making process, as a knowledge gap assessment, and to align vision with implementation.

7.3.3 Current reality needs assessment

The final planning tool that was presented to participants was a current reality needs assessment. This tool gave descriptive metrics similar to the fully prescriptive rubric (and was focused on school readiness, as opposed to leadership team readiness), however it did not provide a spectrum of choices for leaders to choose from in determining their readiness levels. Instead, it gives the ideal level of readiness for implementation and allows leaders to determine how close they are to this level. In this way, leaders are describing for themselves their "current reality" in juxtaposition to the ideal. This planning tool is part of the Technology Needs Assessment produced and distributed by the Arizona Department of Education. Table 10 below describes participants' thoughts on the current reality needs assessment.

Table 10. Responses for Current Reality Needs Assessment

POSITIVE CHARACTERISTICS	NEGATIVE CHARACTERISTICS	USES
Specific (2)	Not useful (1)	Describes "now" – useful for those already implementing (4)
Concrete (1)	Vague (1)	Should combine with fully prescriptive rubric (2)
Easy to use (1)		Helps consider implications of decisions (1)
		Measuring incremental change (1)
		Reflection (1)

The responses show that participants viewed the current reality needs assessment similarly to the fully prescriptive rubric (and this may explain why there are fewer total responses for this rubric, aside from it being last in order). However, the uses for this tool are more widely varied. Participants noted the usefulness of using the tool to assess their readiness after implementation as well as prior to implementation. They also saw the tool as a useful counterpart to the fully prescriptive rubric and as a guide in decision-making and reflection.

7.3.4 Comments on all planning tools

Some school leaders made comments on all of the tools as a group. Though there were only a few of these remarks, it is still worth noting their thoughts. Three participants said that all of the needs assessments would be useful in initial planning of a 1:1 program, two noted that language should be highly considered in constructing a tool, and one remarked that all tools were helpful because they did not leave many open-ended considerations, which would take more effort on the part of a school leader.

Chapter 8: Discussion: Use and Merits of Planning Tools

The data on the use and merits of planning tools suggest that school leaders currently have a need that is unmet in terms of effectively planning a 1:1 implementation. In their descriptions of an ideal tool, leaders noted technical, staff, logistical, and student/parent components that would need to be addressed. A majority of these school leaders did not have access to a comprehensive needs assessment or readiness rubric during implementation and noted that one would have been useful. Taking their reflections on the ideal tool into account and their comparisons of the existing tools, there is room for improvement in the tools that currently exist and implications for developing and using these tools.

8.1 Access to Planning Tools

Over time, school leaders have seen increased access to planning tools. The early implementers of 1:1 programs did not have access to a variety of tools, but those schools that started a year or two later did (though the tools varied largely in structure and content). There was not a consensus among the school leaders of where these tools came from or how they were found. Most schools noted that needs assessments or planning tools in general were either helpful in their implementations or would have been helpful had they utilized them. Therefore, access to good planning tools for 1:1 programs is an issue that should be tackled. Many resources for schools and educators are not easily located or comprehensive, and this leaves a policy concern that needs to be addressed.

8.2 Gaps in Existing Planning Tools

Through their descriptions of an ideal planning tool, the school leaders noted a number of gaps that exist in current planning tools.

8.2.1 Technical

The most widely addressed technical categories that a tool should include were bandwidth, access points, and network. Though these are all facets of most planning tools, it seems that they may lack the necessary detail to successfully assist the implementation of a 1:1 program. For example, one participant noted that a chart that directly relates the number of devices to the amount of bandwidth necessary would be a welcome tool in many districts. He also described the fact that the state of Massachusetts had been working on developing such a tool in conjunction with their schools' technical leaders, but because of a change in administration within the Department of Elementary and Secondary Education, this project had come to a halt.

Another leader suggested that a tool should incorporate the flow of devices throughout the building over the course of the day in order to determine where infrastructure is most necessary. This would need to be a more interactive tool because the solution would depend on the specific details of a schools' layout and schedules. Though many school leaders liked the detailed yet straightforward tools presented later in the interviews, interactive tools may become more important as schools become more sophisticated in their programs and planning.

8.2.2 Staff

Teacher training was an important component of planning tools according to all school leaders; it was the only category noted by every interviewee. Following teacher training, support and resources for teachers were also important to include in a planning tool for most leaders (60% mentioned support and 40% mentioned resources). Though some planning tools are solely focused on the technical elements of implementing 1:1, most of the resources that cover teacher training also cover other aspects of teacher assistance, including support and resources.

One interesting aspect of staff readiness is the vision piece of planning. One participant noted that vision is important for both the school and the teachers, and this is an element that goes largely unaddressed in planning tools. Other support for including vision in a tool comes from the literature and other experts in technology implementation. In a blog post by two experienced school technology leaders, *Philosophical Framework* is one of six critical areas for

1:1 program readiness. Within this area, they note, “It is our experience that schools must answer one important question: *Why are we doing this*?” (Salerno and Vonhof, 2011) This brings up a concern for schools thinking of using technology; without consideration for how the technology will assist students and teachers in meeting learning goals, there is very little reason for a large-scale implementation. However, with thought towards these questions, both administration and teachers can become more united in both their learning goals for students and their use of technology in the classroom.

Including vision in a planning tool also helps to address the other categories for an ideal planning tool mentioned by school leaders, including culture and learning. First, a solid vision should help to unite a school in using technology to benefit students and therefore would create a stronger culture. Secondly, learning is likely the key component addressed by an effective vision, as it should be the school’s main concern for students.

8.2.3 Logistics

All but one school leader noted the importance of including rollout in a planning tool. Rollout describes a variety of activities associated with delivering the devices to students and teachers and setting them up to be used appropriately and effectively. Specifically, 50% of school leaders said they would want something similar to a step-by-step guide to illustrate how to complete an effective rollout. This seems to be an area where planning tools could seriously improve. Though a needs assessment or readiness rubric may address the most important criteria for an effective rollout (how to setup devices or when to give them to teachers), school leaders are looking for more detail, especially in terms of a timeline. Participants expressed the desire to know when to take certain actions and to know how long these actions were going to take. It would be beneficial to school leaders if planning tools included guidance in the form of a step-by-step rollout description.

Another element of planning tools that goes largely unaddressed, but was noted by 30% of school leaders, is a plan for communication. School leaders cited the importance of a plan to communicate not only with the students and teachers involved in the program, but also with the larger group of stakeholders, including parents and the school community. Therefore, a

communication plan to connect with all stakeholders on the topic of the new 1:1 program should be included in planning tools as an additional metric for readiness.

8.2.4 Students and parents

The most often cited component of an ideal planning tool in the category of students and parents was digital citizenship, which is increasingly being covered by planning tools. However, parent education was also noted as an important component of planning by 30% of school leaders. Parent education is not as often addressed. Parents need to support and understand what their children are doing in school, and especially in communities where mobile devices such as iPads are not as prevalent and students are bringing the devices home, parents may feel like they have lost some control over what their children have access to. For this reason, parent education is critical to teach parents not only how to use the devices with their children, but also to inform them about how their children should be using the devices in school and at home. This component of parent education goes hand in hand with family readiness, which was a concern expressed by an additional school leader.

Another interesting trend was the concern about using the iTunes store. Though only 20% of school leaders expressed this concern, its specificity contrasts with the more general aspects of planning that were mentioned and make it worth noting. Concerns with the iTunes store were mainly about how to setup accounts, as they need a source of payment on file. Schools need to determine whether students will be able to use their own iTunes accounts or whether they will be issued accounts through the school with school email addresses. In addition, one school leader noted that in the younger grades, there is an age minimum for creating an iTunes account and parents may have to set these up for their children if students do not meet the minimum age. This would likely only be a problem in the younger middle school grades, as the age minimum is 13 years old. Therefore, for schools using iTunes for app downloading and purchasing, planning tools should incorporate how to setup these accounts for students.

8.3 Improvements to Existing Tools

Based on the gaps described above, there are a number of improvements that could be made to existing planning tools. The following components would aid existing tools: more detail on the necessary technical infrastructure, guidance for forming a uniting vision for the association between technology and learning, a step-by-step guide for rollout, a plan for communication with all community stakeholders, a plan for parent education, and iTunes account policy suggestions. In addition, a detailed calendar would be a welcomed tool for many school leaders who are struggling with rollout details. The calendar should cover everything from the initial pilot to the first year of implementation to give school leaders sufficient guidance. If some flexibility in planning could be incorporated into the calendar to make it interactive and specialized to meet schools' schedules and deadlines, it would be a unique and extremely useful tool for schools planning 1:1 programs.

Chapter 9: Policy Implications – School, State, and Federal

Schools are affected by policy at every level of government – federal, state, and local. In the federal government, there are various laws that apply to schools through the Constitution and the Bill of Rights, such as students' freedom of speech and protection from unreasonable search and seizures (though through tort law, these protections look different for students at school than they do in other public domains). However, despite these over-arching regulations, most school policy, in terms of law, is at the state level. In fact, each state's constitution is what secures the right to an education for students across the country. There are also state-level policies and regulations concerning funding, bullying, and other issues that schools deal with every day. After the state regulations, schools also consider and create numerous local policies to deal with a variety of issues affecting teachers, students, and the community. Recently, technology has been an issue at the center of many new policies.

Policies dealing with technology can be found at every level of government, but many are in the form of guidelines and resources, as opposed to laws or regulations. Most policies that schools follow for technology are set at the local level by a school board or even a school's principal or lead administrator. As large-scale technology initiatives increase, the need for supportive policies at all levels increases as well. Administrators and school leaders are looking for guidance in this realm; policies that support technology implementation at the local, state, and federal levels can help bring these technology-rich environments to students. The research presented in this thesis thus far shows the ways in which schools need to prepare for technology programs and the best methods in planning. These results serve as groundwork for recommendations as to how policies should be constructed to aid school leaders in implementation of 1:1 initiatives.

9.1 Federal-level Polices and Possible Implications

At the federal level of government, most policy concerning technology is designed to help promote the use of technology in classrooms and ease the burden on schools. However,

policy efforts at this level have been limited. Improvements could be made to further ease the burden on schools, especially in terms of support and access to resources. The U.S. Department of Education (henceforth, 'DOE') has the unique ability to unite schools across the country and should utilize this ability to meet the needs that schools currently encounter in implementing 1:1 programs.

9.1.1 President Obama's ConnectED Initiative

In 2013, President Obama announced the ConnectED Inititative, aimed at improving technology in classrooms across the country in order to enrich learning and further engage students. The overarching goal of the initiative is to have adequate broadband Internet access in 99% of classrooms in the United States by 2018. Through this announcement, the President directed the federal government to improve not only Internet connectivity, but also educational technology in classrooms. Though there is not an associated congressional action, the President asked local communities, states, and private businesses to support technology in the classroom as well (ConnectED, 2013).

In connection with this stated goal, in February of 2014, the Federal Communications Commission (FCC), along with a number of private businesses (including Apple, AT&T, and Microsoft), pledged significant funds to support technology in public schools. Specifically, the FCC will invest $2 billion through 2016 to expand high-speed Internet connectivity for the country's schools and libraries (The White House, 2014). Other companies, such as Apple and Microsoft, have pledged millions of dollars in free and discounted products for students and teachers.

The President's call to action to support technology in schools has clearly had an impact on many technology leaders and is beginning to widen the opportunity for Internet access and devices in all schools across the US. Despite the fact that this call was not written into policy, it still has had a large effect. Accordingly, specific calls to action may be an appropriate measure for bringing in general support and products to an issue like education technology. Unfortunately, they cannot produce the specific types of support and implementation assistance that are necessary for schools to be truly successful in utilizing their new tools and opportunities.

Bringing the devices and connectivity to schools is not enough and must be supported with further policies.

9.1.2 Future Ready Schools

The DOE in conjunction with the Alliance for Excellent Education began a program in 2014 called Future Ready Schools (FRS). FRS is an initiative that helps districts by providing resources and support "to ensure that local technology and digital learning plans align with instructional best practices, are implemented by highly trained teachers, and lead to personalized learning experiences for all students, particularly those from traditionally under-served communities" (Future Ready Schools, 2014). Currently, the main components of the program are a pledge and free regional summits, but soon a leadership network will be added.

The leadership network will be an excellent opportunity for FRS to fill some of the gaps that currently exist for schools going 1:1. First, there is an opportunity to unite schools with mentor schools across the country. An oft-cited best practice in planning is to learn from other schools that already have implemented technology initiatives. Through the leadership network, FRS could create a platform for connecting schools that are in the planning phases with experienced schools that are willing to be mentors. In addition, the leadership network plans to provide an "interactive planning dashboard" to help districts analyze and report on their school's progress (Future Ready Schools, 2015). This is also an opportunity for FRS to fill the gap in planning tools. Particularly, this dashboard should include a comprehensive planning tool with a detailed calendar for suggested rollout procedures. With these additions, the leadership network of FRS has the potential to significantly improve planning processes for schools implementing 1:1 programs.

9.1.3 Funding

The most notable way that money is tied to technology for schools in the federal government is through the program commonly known as "E-rate". E-rate is the name typically used for the Schools and Libraries Program of the Universal Service Fund, which is under the direction of the FCC. E-rate provides discounts for schools and libraries for telecommunications

and Internet access. The money comes from the "Universal Service Fee", which is charged to companies providing interstate or international telecommunications services. Schools can apply for E-rate funding independently or as a group, and the amount awarded is determined in large part by the level of poverty and the urban/rural status of the school. Schools are awarded discounts ranging from 20% to 90% of connectivity costs (Jackson, 2004).

E-rate has been successful in assisting the expansion of connectivity in schools across the US, and annual requests for funding have nearly tripled the FCC's $2.25 billion limit in past years (Gilroy, 2003). Schools are continuing to rely on this source of funding for Internet access, and the E-rate program was mentioned in a number of interviews for this research. The E-rate program, along with other federal initiatives to increase access to technology resources, have been successful in helping schools towards universal connectivity. However, connectivity alone is not enough and other measures must be put in place to ensure that the programs are both successful and sustainable for students and teachers. E-rate might further assist schools in sustainability by providing resources to help with budgeting and resource allocation, which are critical metrics for school-level planning as described in the readiness rubric.

9.2 State-level Policies and Possible Implications

State-level policies governing schools vary widely across the country. The vast majority of a school's funding comes from the state and local levels. In recent years, on average, the state and local governments each provide about the same amount of funding to schools at 44%, while the federal government provides just 12% (Federal Education Budget Project, 2014). States are increasingly supporting funding for technology initiatives in schools through grant programs. One such example is the Wisconsin Technology Initiative, which aims to advance the use of technology in learning environments throughout the state of Wisconsin. Similarly, states might allocate a certain portion of the budget to specific technology-based enhancements for schools. Massachusetts has created budget-based support for improvements in infrastructure. These two initiatives illustrate the types of policies that states can adopt to aid education technology in schools.

There is a lot of room for states to support schools in technology use through their financing and resources. There is also room for states to create mentoring structures at a more

intimate level because of the proximity of the schools affected. Below, the aforementioned Wisconsin and Massachusetts technology initiatives are described, in addition to an explanation of the possible roles for the state to play in supporting schools with technology implementation.

9.2.1 Wisconsin Technology Initiative

The Wisconsin Technology Initiative provides grants to public schools and other educational facilities to implement instructional technology in learning environments. Specifically, the initiative gives funding to schools to purchase interactive whiteboards and to improve professional development for teachers. The first round of grants will go to schools that commit to both interactive whiteboards and professional development to support the use of the whiteboards. Schools that are awarded the grants are then expected to share their best practices across the state (Wisconsin Technology Initiative, 2015). By tying funding to improved professional development and sharing of best practices, Wisconsin creates a strong initiative for schools to train teachers well. In addition, through the sharing of best practices, the state is creating a more collaborative community of technology-rich schools that can learn from one another to improve implementation. States might consider structuring 1:1 or education technology funding programs in the same way to ensure adequate training and the sharing of best practices.

9.2.2 Massachusetts' bond bill for infrastructure

In 2014, Massachusetts' Governor Deval Patrick signed into law H.3770: "An Act Financing Information Technology Equipment and Related Projects". This piece of legislation extends to support the state's entire infrastructure, but includes a special provision just for public schools. In particular, a $38 million grant program allows schools to apply for grants to bring high-speed Internet to their campuses. The Director of Digital Learning in Massachusetts has begun to work with schools on applications for support from this grant and on utilizing these new resources to expand access to technology for their students (Ken Klau, personal communication, October 10, 2014).

9.2.3 Mentoring programs

States such as Massachusetts and Wisconsin have been taking initiative to bring money dedicated to expanding technology into their public school systems. However, there are many possibilities for states to take their roles much further than grant programs and to provide the support that school systems need in implementation. One way that states could support schools would be in setting up technology mentoring programs. States are already looking for connections and mentors when starting 1:1 programs, and the state is in the unique position to assist in this process. Technology-rich schools may be clustered for this reason; they are able to learn from one another. As one technology director in this study commented,

> *"One of the things I've seen is that you get these clusters in a region of 10-20 districts going 1:1. Then there's an area where no one is really going 1:1. Four years ago, there was a really big burst of districts going 1:1 because we were all hearing from each other about it. (This region) was a good place to connect."*

The state should take a role in connecting districts in their technology efforts. First, it would be useful for the state to provide information on the innovative things that schools are doing. This could be a basic statewide resource where schools submit annual updates and these updates are published. Generally, schools like to promote the innovate things that they are doing, so asking schools for these updates may not present too much of a burden for a district. Next, there should be functionality in the resource for schools to connect with one another. This could be done simply, by listing the technology contact person at each school, or by a more robust infrastructure. Either way, this would allow districts to easily connect with one another on the topic of education technology.

The state may be able to take these connections a step further by creating mentoring relationships the schools. For example, a school district could sign up because it wants guidance in implementing an iPad 1:1 program. The state could connect this district to a nearby district with a similar program to serve as a mentor. Incentives for the mentor school may be necessary, but perhaps schools would be open to sharing best practices without large (financial) incentives. This would be something to consider on a state-by-state basis and worth some thought.

States have the position to aid school districts in technology-planning partnerships and should create the infrastructure necessary to allow schools to connect with one another and share best practices. Mentoring relationships during planning were essential to nearly all of the schools in this study, and it is important that the state step in to assist schools in forming these relationships.

9.2.4 Joint professional development

One of the most commonly cited needs in planning is teacher training. When left up to each individual school, this training is difficult and expensive to execute. The state could have a role in orchestrating professional development for teachers and schools. It may make sense for the state to simply connect schools that are looking to organize joint professional development, or the state may take a larger role and run the professional development itself.

In Massachusetts, the Office of Digital Learning is considering moving a significant amount of professional development for teachers online over the coming years (personal communication, Ken Klau, October 10, 2014). These courses and seminars cover largely traditional teacher training content, but could be expanded to cover teacher training for utilizing technology in the classroom. Teachers or schools that are ahead of the curve may be open to creating this technology-based content for other teachers in the state and their knowledge should be utilized.

9.3 Local-level Policies and Possible Implications

Though the federal and state governments have their role in policies that affect education technology, the majority of policy at the school level is left up to the local school board and administration. Forming good policy at this level, as can be seen through this study, is essential to the success of a 1:1 program in a district. Particular attention should be paid to the use of needs assessments, sustainable funding and resource policies, and relationships with other schools and vendors.

9.3.1 Use of needs assessments

First, in Chapters 7 and 8, the use and merits of planning tools were explored. Though their use varied by district, their merit in certain circumstances was universal; no school leader denied that a planning tool would be useful in starting to plan a 1:1 program. However, many of these schools did not have access to a planning tool because of early adoption or lack of awareness of resources.

A thorough needs assessment is important for a district considering a large-scale technology initiative. The use of this tool will illuminate potential pitfalls and allow school leaders to address them before implementation. It may make sense for multiple needs assessments to be used in order to cover different topics. For example, a team-oriented needs assessment might first be used to determine the readiness of the team to implement technology. After addressing the team's gaps in knowledge, a school systems-based assessment could further highlight gaps in the school's infrastructure, training, and culture. Though the types of tools could vary from school to school, it is important that schools make needs assessments an important piece of their planning regimen.

9.3.2 Funding and resources

Most of this research addresses local policy issues, including the need for a sustainable model of funding and resources. The readiness rubric and sustainable implementation model both highlight the need for budgetary and expense systems that do not rely on one-time grants or inappropriately allocate funds for or away from teachers for resources. It is necessary to consider resource structures, including hardware, software, support, and training, and how these resources will fit into the school's current and planned systems. Policies for budget and resource allocation can vary across schools, but they should reinforce sustainability for the technology.

Schools should be aware of the various costs they may incur when starting a 1:1 program. Reported costs can range from $250 to $1000 per student, including hardware, software, refresh cycles, professional development, and teacher training (Greaves, 2008). Though there are ways that schools can save money from switching to 1:1, such as replacing textbooks and communicating electronically, these programs should not be seen as a cost-saving measure.

Greaves (2010) outlines the differences in cost in a traditional 3:1 student-computer ratio school to a "technology transformed" 1:1 school, and estimates that a 1:1 school has about double the costs in technology implementation in comparison to a traditional school. Figure 3 illustrates these differences.

Traditional 3:1 Student-Computer Ratio School		1:1 Technology-Transformed School	
Hardware		**Hardware**	
$1,000	Cost of student computer with 4-year warranty	$900	Cost of student computer with 4-year warranty
$1,100	Cost of teacher computer with 4-year warranty	$1,100	Cost of teacher computer with 4-year warranty
$7,600	Total cost of 1 printer per classroom plus 2 for common areas (20 b/w laser printers and 2 color laser printers)	$9,200	Total cost of 1 printer per classroom plus 4 for common areas (20 b/w laser printers and 4 color laser printers)
$202,100	Total cost over 4 years	$509,200	Total cost over 4 years
$101	**Cost per student per year**	**$255**	**Cost per student per year**
Servers, router, firewall, and related software		**Servers, router, firewall, and related software**	
$25,000	Cost of servers, router, firewall, and software	$50,000	Cost of servers, router, firewall, and software
$13	**Cost per student per year**	**$25**	**Cost per student per year**
Annualized software costs		**Annualized software costs**	
$50	Cost per student per year for instructional software	$50	Cost per student per year for instructional software
$13	Cost of productivity tools per student computer	$40	Cost of productivity tools per student computer
$25	Cost for LMS, assessment, etc.	$25	Cost for LMS, assessment, etc.
$8	Installation and customization costs per student	$13	Installation and customization costs per student
$96	**Cost per student per year**	**$128**	**Cost per student per year**
Wireless network		**Wireless network**	
$2,000	Cost per classroom/common area, includes POE	$3,000	Cost per classroom/common area, includes POE
$50,000	Total infrastructure	$75,000	Total infrastructure
$14	**Cost per student per year**	**$22**	**Cost per student per year**
Telecom (10 Kilobits/sec/student average)		**Telecom (50 Kilobits/sec/student average)**	
$75	Cost per megabit at 5 megabits/second rate	$50	Cost per megabit at 25 megabits/second rate
$225	Cost per month	$1,250	Cost per month
$2,250	Cost per year (10 months)	$12,500	Cost per year (10 months)
$5	**Cost per student per year**	**$25**	**Cost per student per year**
Tech support (0.25 dedicated tech support person, presumes 4-year hardware warranty)		**Tech support (0.5 dedicated tech support person, presumes 4-year hardware warranty)**	
$75,000	Cost of tech support person plus overhead	$75,000	Cost of tech support person plus overhead
$38	**Cost per student per year**	**$75**	**Cost per student per year**
Professional development (0.25 trainer year 1, 0.125 trainer years 2-4)		**Professional development (0.50 trainer year 1, 0.25 trainer years 2-4)**	
$100,000	Cost of PD person, fully burdened	$100,000	Cost of PD person, fully burdened
$62,500	Total cost	$125,000	Total cost
$31	**Cost per student per year**	**$63**	**Cost per student per year**
$298	**Total cost per student per year**	**$593**	**Total cost per student per year**

Figure 3. Difference in Costs: Traditional vs. Technology-Transformed School (Greaves, 2010)

Schools need to be aware of the costs of a 1:1 program and plan accordingly. Good policy at the school level will take these costs into account and do a thorough cost-benefit analysis to determine the particular details of a financially sustainable model for education technology.

9.3.3 School purchasing decisions

Technology-rich schools need to make a number of purchasing decisions for hardware, software, and even training programs. Unfortunately, the procurement process for technology is confusing and difficult to navigate for schools that want the best products in their classrooms. There are a number of reasons for this, but Levy (2013) notes that some of the specific problems include a lack of awareness of what products are available and a lack of guidance in selecting the best products for their circumstances and needs. One suggestion he makes is that a type of consumer report should be available for schools to aid in decision-making. In this way, a third party would evaluate products and comment on their uses and quality. Districts might think about combining forces and creating something like this locally to assist in technology purchasing decisions. Furthermore, it is important that different stakeholders' views are taken into account in purchasing decisions. Ultimately, the superintendent of a district has the final say, but they should not work in a vacuum. Similarly to the readiness rubric's recommendation to include various stakeholders on a planning committee, stakeholders such as teachers, administrators, and students should be included when major purchasing decisions for hardware or software need to be made.

Chapter 10: Conclusion and Future Research

As technology continues to grow in popularity in the classroom, it is necessary for adequate evaluations and metrics to be developed to measure the readiness of schools to adopt such technologies. This thesis aims to establish a framework and series of metrics to measure school and district readiness to adopt a 1:1 initiative. Best practices were drawn through the case studies of current 1:1 schools. Though those best practices will continue to evolve over time, the sustainable implementation model provides guidelines for administrators thinking about a 1:1 program for their schools. The rubric should be used by administrators to identify areas of weakness before implementation. When considering improvements and support structures, administrators should strive to meet the "excellent" category as best they can. The rubric will lead administrators to put their time and resources towards those categories that are not up to par.

As the second half of the research revealed, school leaders have mixed practices in using planning tools. However, it was unanimous that a planning tool could be helpful in starting a 1:1 program, despite the fact that many did not have them available when they were planning. Most school leaders had preferences for tools that were concrete, easy to use, and detailed; however, preferences for the tools ranged. The most frequently stated aspects for an ideal planning tool to cover were technical infrastructure (such as bandwidth and access points), teacher training, and roll out. The desire for a detailed roll out calendar was also expressed, and this is a gap that could be filled with improvements to existing tools. Moreover, though a variety of tools do exist and likely cover many of the topics the school leaders felt were lacking, they are not always easily available resources. The state and federal governments are in a unique position to provide resources for school leaders and assist in creating a network of technology-rich schools that are able to connect with one another.

10.1 Further Research: Readiness Rubric

There is much room for further research in the area of technology readiness in education. Because this research only included six schools and there are many more implementing 1:1 programs, much more data could be collected for a more thorough analysis. Specifically, more research in the areas of insurance and repairs, timing of deployment to teachers and students, and

teacher training would be beneficial. Furthermore, best practices were deemed "best" by the respondents; there was not a universal measure of success by which to measure the implementations. In the future, a metric for success (such as learning or development of skills) should be used to measure best practices, instead of a reliance on self-reporting of successes and failures.

The rubric is intended to help administrators in their decision-making processes in instituting a 1:1 program. There might also be research in the effectiveness of using such a rubric in schools, and the ultimate impact on the ease and success of an implementation on schools that do use the rubric in their planning process. A verification and validation of the rubric and sustainable implementation model would further solidify its value.

10.2 Further Research: Planning for Technology

In the planning piece of this research, the uses and merits of planning tools were explored. Again, there is room for a more in-depth analysis because only 10 school leaders were interviewed. However, trends were seen through their responses, and therefore, it is unclear if a larger group of school leaders would elaborate further upon what has already been discovered. Nonetheless, an increased sample size of school leaders is bound to provide more significant results.

One area for further exploration is in different types of devices and blended learning environments. For sake of simplicity, 1:1 iPad programs were the focus for this research, but many other types of 1:1 programs exist, including laptops, Chromebooks, and BYOD. It is likely that leaders implementing these other programs may have different tendencies in planning. Given the trend towards Chromebooks recently, it would be worthwhile to determine if there are different best practices in planning an iPad 1:1 in comparison to planning a Chromebook 1:1 program.

In addition, schools are beginning to move towards "blended learning" environments, which describe a variety of ways to incorporate technology into the classroom. These types of learning environments range from a traditional 1:1 program to more innovative programs that involve models rotating students around the classroom and using other teaching methods to achieve the best learning environment for students. Currently, most 1:1 schools are starting with

the technology and then determining how students and teachers fit into the bigger picture. In the future, schools should start with the need to better serve students and then creatively design a technology space to fit their needs. Most of the schools interviewed in this research were somewhere in between these two ends, but planning should increasingly focus on formatting the technology learning environment to better meet the needs of teachers and students, and not the other way around.

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Appendix A: Rubric to Determine Readiness for 1:1 Implementation

TECH READINESS		NEEDS IMPROVEMENT	SATISFACTORY	GOOD	EXCELLENT
Infrastructure	*Bandwidth*	Wireless Internet exists at the school, but there is not enough bandwidth for all students to be online at the same time.	Wireless Internet can support all students online, but slows when students access other media content (videos, music, etc)	Wireless Internet supports all content-creation and media activities, but is reaching 100% of capacity. Guideline: 100Mbps per 1000 students/staff.	Wireless Internet supports all content-creation activities and has excess capacity for adding additional devices. Guideline: 1Gbps per 1000 students/staff.
	Access Points	Wireless access is spotty throughout the school building because of a lack of access points.	There is an access point in every other classroom.	There is an access point in every classroom, and at least one in the larger learning areas (library, gym, etc).	There is an access point in every classroom, and multiple access points in the larger learning areas (library, gym, etc).
	Network	No consideration has been given to how to keep students on the school network. They can access inappropriate content.	Inappropriate content is blocked and consideration is given to blocking other "distracting" sites.	Inappropriate content is blocked and other sites (such as social media sites) are considered individually and blocked (or not).	Access to sites is consistently monitored, re-evaluated, and updated in terms of the needs and wants of teachers and students.
Management	*Device Management Systems*	There is no system in place to manage apps, e-books, and devices.	IT staff member manages buying and loading apps onto devices for students. There is no flexibility for making changes.	IT staff member manages buying and loading apps onto devices for students. There is flexibility for making changes.	There is an app management system and school-owned apps; access can be easily transferred between students.
	Email	Email is not used in the school district.	Teachers have school-assigned email accounts, but students do not.	Teachers and students have school-assigned email accounts.	Teachers, students, and families have school-assigned email accounts.

	Repairs	There is no system in place to handle repairs.	There is a recommended repair facility; insurance is not discussed with or recommended to parents.	Insurance is highly recommended to parents; students are responsible for handling repairs (with or without insurance).	Insurance is provided by school and school handles all repairs.
SCHOOL READINESS		**NEEDS IMPROVEMENT**	**SATISFACTORY**	**GOOD**	**EXCELLENT**
Financing	*Budgeting for buying/leasing devices*	There is not enough money in the budget to support the 1:1 program for all grade levels.	1:1 budget created from one-time grants, with hope for winning outside funding or finding additional internal funding in the future.	1:1 budget is a capital expense, which needs to be renewed annually (or periodically, depending on structure of lease/purchases). All funding from internal sources.	1:1 budget is an operating expense, and therefore an annual line item. All funding from internal sources. Financial sustainability is more or less guaranteed.
	Trade-offs	All computer labs, textbooks, and other hard copy materials are shut down or taken out of the budget.	Some computer labs are revamped, textbooks only remain if requested by teachers, and other tech trade-off decisions are made on an ad-hoc basis.	Careful consideration is given to tech trade-offs by administrators; decisions are made after instituting the 1:1 program - some feedback might be solicited.	Trade-offs with resources that could be replaced with tech are determined jointly by teachers, administrators, and tech staff.
	Repairs	No funding or guidance is given on how to repair broken devices. School haphazardly pays for repairs without a fixed budget.	School has partnership with repair facility and has negotiated a good price for those who opt for insurance.	School provides insurance for low-SES students and uses partnership with repair facility to negotiate a good price for those who opt for the recommended insurance.	School provides insurance for all students and insurance costs are an integral part of the budget.
	Budgeting for apps/software & other tech	There is no budget for apps, software, or other technology (such as computers) used in the school.	School provides some resources in terms of apps, software, and other technology.	School provides adequate options for teachers in terms of purchasing other apps or software, and retains computer labs and other technologies.	School is very flexible in providing desired software and apps for teachers, while maintaining and responding to requests for other technologies.

Planning	*Committee*	No committee is in place at any time during the planning process.	A group of administrators and IT staff lead the planning process.	A committee with administration, IT, and teacher representation lead the planning process.	A committee with representation from IT, teachers, parents, students, and the community help administrators in the planning process.
	Teacher Support	Teachers are largely opposed to the 1:1 initiative during the planning process.	Teacher reception of the 1:1 initiative is mixed; however, with the promise of tech support, many teachers acquiesce.	Teachers are largely supportive of the 1:1 initiative during the planning process.	Most teachers are excited to get started with the 1:1 initiative and many volunteer to help in planning.
	Mentor Schools	No other 1:1 schools are contacted or studied during the planning process.	One 1:1 school serves as a mentor school during the planning process to assist with barriers and implementation.	Multiple 1:1 schools serve as mentor schools, and at least one is visited during the planning process.	Multiple 1:1 schools serve as mentor schools, many are visited, and strong working relationships are bulit.
	Pilot / Testing	No pilot or device testing is done prior to full school implementation.	Some testing or a small pilot is done before full school implementation.	Multiple devices are considered and tested before implementation and a small pilot is conducted.	Multiple devices are thoroughly tested before implementation and a small pilot including classes in various grade levels is conducted.
TEACHER READINESS		**NEEDS IMPROVEMENT**	**SATISFACTORY**	**GOOD**	**EXCELLENT**
Planning	*Deployment*	Teachers do not receive devices when students receive theirs.	Teachers receive devices at the same time as students.	Teachers receive devices less than one full school year before students receive theirs.	Teachers receive devices one full school year before students receive theirs.
	Training - Quality	Teachers do not receive any professional development in association with new devices and technology.	Teachers attend professional development sessions on using the devices and apps, but not pedagogical practices.	Teachers attend professional development on devices and apps, and also pedagogical practices in technology use.	Teachers attend professional development on the devices, apps, pedagogical practices. They are also given time during training to work collaboratively and explore different use cases.

	Training - Frequency	Teachers do not receive any professional development in association with new devices and technology.	Teachers attend at least one full day of professional development in association with new devices and technology.	Teachers attend 2-4 full days (or the equivalent over the course of a year) of professional development in association with new devices and technology.	Teachers attend 5+ (or the equivalent over the course of a year) days of professional development in association with new devices and technology.
On-Site	*IT Support*	There is no IT support available on site.	There is one part time staff member available for IT support on site.	There is one full time staff member available for IT support on site.	There is one full time staff member for every 500 devices on site.
	Instructional Tech Support	There is not any kind of instructional technology support available for teachers.	There is a teacher who serves as the main instructional technology support person.	There is a part time staff member who is an instructional technology support specialist.	There is at least one full time staff member who is an instructional technology support specialist.
	Student Support	There are no venues of student-led support.	There is a student-led help desk that is available after school at least one day per week.	There is a student-led help desk or team of students available most days to provide tech support to teachers and students.	There is an identified team of students (across grade levels) who provide technology support to teachers and other students (through a help desk, or otherwise).
	Teacher to Teacher Support	There is very little teacher to teacher support.	Teachers help other teachers informally.	There is a formal system for teachers to identify strengths and offer support to other teachers.	There are multiple teachers who have a reduced class load to serve as tech-leads and support for other teachers.
	Ongoing PD	There is no ongoing professional development in relation to technology.	There is professional development at least once per semester for technology.	There is professional development and collaboration time for technology at least twice per semester.	There is built in professional development and collaborative time for technology on a weekly or monthly basis.

Resources	*Access*	Teachers do not have access to the resources (apps, software, etc) they need or do not know how to access them.	Teachers have access to a fixed set of resources (apps, software, etc) that provide the basics of what they need.	Teachers have access to a continually evolving set of free & paid resources and can access everything they need.	Teachers have access to all of the resources they need, and when they find an additional resource they would like to use, it is quickly available to them through device updates (if necessary).
	Content Creation	Teachers do not engage in content creation, nor do they individualize materials that are found online.	Teachers have individualized materials found online and created some digital materials.	Teachers create and revamp most of their materials digitally.	Teachers create and revamp all of their materials digitally and have created their own digital textbooks for school use.

Appendix B: Surveys

Administrator/ Teacher Survey

Administrator/Teacher Tech Survey

1. School Information

Please answer the following questions about your school. You may leave questions unanswered if you do not have the appropriate information. Thank you!

***1. School Name (please type the entire name of the school - ex. Type "Burlington High School", not "BHS")**

***2. State**

***3. Description of your position at the school (principal, teacher, IT staff, etc)**

4. Enrollment by Grade Level (enter 0 for any grades not at your school)

K	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

5. School Type

- Public
- Private
- Charter

Other (please specify)

Administrator/Teacher Tech Survey

6. Community Description

- ☐ Urban (large city)
- ☐ Small City
- ☐ Large Town
- ☐ Small Town
- ☐ Rural

Other (please specify)

7. Percent (%) of students eligible for free or reduced lunch

8. Percent (%) of students who have a computer at home

9. Percent (%) of students who have internet access at home

10. Number of classrooms

11. Number of classrooms including portables used as classrooms, labs, and/or libraries

Administrator/Teacher Tech Survey

2. Technology Access

12. Number of classrooms with wired internet access (not including wireless classrooms)

13. Number of sets of student response systems (ie. SMART response, clickers, etc)

14. Number of whole-classroom interactive devices (e.g., whiteboards such as SMARTBoards, Promethean, Hitachi; interactive projectors)

15. Number of laptops provided/available for student use

16. Number of tablets provided/available for student use

17. Does your building provide wireless access to the Internet?

- Yes
- No

18. If yes, is that access available in (select one):

- One classroom or meeting room only
- More than one classroom or meeting room, but not building-wide
- Central areas throughout building (but not classrooms)
- The entire building

19. Percentage (%) of students with district- or school-provided email accounts

20. Percentage (%) of teachers and administrators with district- or school-provided email accounts

21. Do you have one or more grades in your school that have a one-to-one initiative (e.g., laptops, tablets, netbooks)?

- Yes
- No

Administrator/Teacher Tech Survey

22. If yes, please describe:

23. If yes, are students allowed to take devices home?

24. Number of computer labs in your school

25. Number of computers in each lab (please separate by semi-colons)

26. How are the labs utilized? (select all that apply)

- [ ] Instructional use
- [ ] CTE classes
- [ ] Title I classes
- [ ] Formative assessment
- [ ] State summative assessment
- [ ] Community access
- [ ] Professional development
- [ ] Classroom Instructional Tools

Other (please specify)

Administrator/Teacher Tech Survey

3. Potential Problems

How concerned are you about the following potential problems?
On a scale of 1-6, where 1="no concern" and 6="extreme concern"

27. Teachers having sufficient technical understanding to support students

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

28. Providing all appropriate training needed for teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

29. Having a sufficient number of technology support staff to support teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

30. Technology support staff having sufficient technical understanding to support teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

31. Providing all appropriate training needed for technology support staff

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

Administrator/Teacher Tech Survey

4. Tech Standards and Initiatives

32. Are there district staff assigned to provide professional development in technology integration as part of their regular FTE?

- ○ Yes
- ○ No

33. Is there an additional stipend to one or more district employees to provide professional development in technology integration?

- ○ Yes
- ○ No

34. Are there building-level staff assigned to provide professional development in technology integration as part of their regular FTE?

- ○ Yes
- ○ No

35. Are there additional stipends to building-level employees to provide professional development in technology integration?

- ○ Yes
- ○ No

36. Are there technology standards for teachers?

- ○ Yes
- ○ No

37. If yes, are they required?

- ○ Yes
- ○ No

38. If there are technology standards, what methods of assessment are used? (select all that apply)

- ☐ self-reporting
- ☐ classroom-based assessment
- ☐ formal assessment/test
- ☐ portfolio
- ☐ culminating project

Administrator/Teacher Tech Survey

39. Are there technology standards for administrators?

- Yes
- No

40. If yes, are they required?

- Yes
- No

41. If there are technology standards for administrators, what methods of assessment are used? (select all that apply)

- self-reporting
- classroom-based assessment
- formal assessment/test
- portfolio
- culminating project

42. Number of FTE at district and building level paid as IT support to provide technical support to buildings and district office

43. In addition to this technical support, are there stipends provided to individuals at the building level to provide technology support?

- Yes
- No

44. Is your school using or considering any of the following? (select one answer per row)

	Using	Considering	Not using or considering
Google Apps for Education			
Live@Edu			
Other cloud computing solutions			
Gaming for teaching and learning			
Flipped classroom			
Blended learning			

45. Please describe all initiatives selected above that you are using or considering using:

46. If you would be willing to further discuss technology and the tech initiatives at your school, please enter your email address below:

IT Staff Tech Survey

School Information

Please answer the following questions about your school. You may leave questions unanswered if you do not have the appropriate information. Thank you!

***1. School Name**

***2. State**

***3. Description of your position at the school (administrator, teacher, IT staff, etc)**

4. Percent (%) of students who have a computer at home

5. Percent (%) of students who have internet access at home

6. Number of classrooms with wired internet access (not including wireless classrooms)

7. Number of sets of student response systems (ie. SMART response, clickers, etc)

8. Number of whole-classroom interactive devices (e.g., whiteboards such as SMARTBoards, Promethean, Hitachi; interactive projectors)

9. Number of laptops provided/available for student use

10. Number of tablets provided/available for student use

11. Does your building provide wireless access to the Internet?

- Yes
- No

IT Staff Tech Survey

12. If yes, is that access available in (select one):

- ○ One classroom or meeting room only
- ○ More than one classroom or meeting room, but not building-wide
- ○ Central areas throughout building (but not classrooms)
- ○ The entire building

13. Percentage (%) of students with district- or school-provided email accounts

14. Percentage (%) of teachers and administrators with district- or school-provided email accounts

15. Do you have one or more grades in your school that have a one-to-one initiative (e.g., laptops, tablets, netbooks)?

- ○ Yes
- ○ No

16. If yes, please describe:

17. If yes, are students allowed to take devices home?

18. Number of computer labs in your school

19. Number of computers in each lab (please separate by semi-colons)

IT Staff Tech Survey

20. How are the labs utilized? (select all that apply)

- [ ] Instructional use
- [ ] CTE classes
- [ ] Title I classes
- [ ] Formative assessment
- [ ] State summative assessment
- [ ] Community access
- [ ] Professional development
- [ ] Classroom Instructional Tools

Other (please specify)

IT Staff Tech Survey

Potential Problems

How concerned are you about the following potential problems?
On a scale of 1-6, where 1="no concern" and 6="extreme concern"

21. Teachers having sufficient technical understanding to support students

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

22. Providing all appropriate training needed for teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

23. Having a sufficient number of technology support staff to support teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

24. Technology support staff having sufficient technical understanding to support teachers

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

25. Providing all appropriate training needed for technology support staff

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

IT Staff Tech Survey

Device Specifications

For schools with 1:1 iPad or laptop programs - please provide the specifications of the devices provided to all students.

26. Operating system

27. Processor (Type/Speed/Capacity)

28. Memory

29. Resolution

30. Monitor/Display size

31. Web browser

32. Wireless connection

- Yes
- No

33. Device type

IT Staff Tech Survey

Network Specifications

34. Estimated Internet Bandwidth

35. Estimated Internal Network Bandwidth

36. Estimated Internet Network Bandwidth Utilization

37. Estiamted Internal Network Bandwidth Utilization

38. Wireless Access Points Count

39. Wireless Access Points Count

40. Estimated Maximum Network Speed

IT Staff Tech Survey

Tech Standards and Initiatives

41. Are there technology standards for teachers?

- ○ Yes
- ○ No

42. If yes, are they required?

- ○ Yes
- ○ No

43. If there are technology standards, what methods of assessment are used? (select all that apply)

- ☐ self-reporting
- ☐ classroom-based assessment
- ☐ formal assessment/test
- ☐ portfolio
- ☐ culminating project

44. Are there technology standards for administrators?

- ○ Yes
- ○ No

45. If yes, are they required?

- ○ Yes
- ○ No

46. If there are technology standards for administrators, what methods of assessment are used? (select all that apply)

- ☐ self-reporting
- ☐ classroom-based assessment
- ☐ formal assessment/test
- ☐ portfolio
- ☐ culminating project

IT Staff Tech Survey

47. Is your school using or considering any of the following? (select one answer per row)

	Using	Considering	Not using or considering
Google Apps for Education	○	○	○
Live@Edu	○	○	○
Other cloud computing solutions	○	○	○
Gaming for teaching and learning	○	○	○
Flipped classroom	○	○	○
Blended learning	○	○	○

48. Please describe all initiatives selected above that you are using or considering using:

49. If you would be willing to further discuss technology and the tech initiatives at your school, please enter your email address below:

Appendix C: Interview Questions: Best Practices for Implementation

Interview Questions – Teachers, Administrators, and IT Staff

I) How, if at all, has the implementation of the 1:1 iPad initiative affected the curriculum at your school? {ie. lesson structure, pedagogy)

II) How, if at all, has the implementation of the 1:1 iPad initiative affected teachers in terms of engagement at your school?

III) How, if at all, has the implementation of the 1:1 iPad initiative affected teachers in terms of administrative requirements at your school? (ie. more or less accountability, forms, documentation, etc)

IV) How has the implementation of the 1:1 initiative affected classroom management?

V) What, if any, technical issues have emerged?

VI) What, if any, kinds of support are available for teachers and staff in relation to the 1:1 initiative?

VII) How, if at all, has the iPad affected the use of other technologies?
   a. In-classroom (smartboards, clickers, etc)
   b. Outside the classroom (computer labs, libraries, etc)

VIII) What, if any, improvements would you suggest be made to the iPad program?

IX) What do you feel are the biggest positive outcomes as a result of the iPad program?

Purchase Decision-Making Questions – Administrators & IT Staff ONLY

I) Who was involved in making the decision to purchase the iPads?
   a. Admins, school committee, IT staff, students?

II) How was the decision made?
   a. Pilots, testing, studies, etc?

III) Where did the funding come from? (Need to report back to anyone else? State/grant funds?)

IV) How has budgeting been determined for accessories, software, etc (non-hardware)?

Appendix D: Codes Used for Readiness Analysis

- Budget
- Classroom Management
- Communication
- Curriculum
- Digital Citizenship
- Learning
- Other Technologies
- Parents
- Planning & Pilot
- Resources
- School-wide Policies
- Student Impact
- Support
- Teacher Impact
- Tech Specifics

Appendix E: Interview Questions on Planning Practices and Tools

I) Did you use any kind of needs assessment or readiness rubric in your 1:1 planning phases?
   a. If no, why not?
      i. What would have helped?
      ii. What kind of guidance were you looking for in planning?
      iii. Were there other sources of reference that were useful?
         1. What were they?
   b. If yes, what type?
      i. Did you find it useful?
      ii. Did it lack anything?
      iii. Why did you choose this particular one?

II) What would an ideal needs assessment gauge for a school thinking of going 1:1?

III) How personalized should a needs assessment be?
   a. Is it necessary for there to be a follow up consultant?

The following three pages show the document that was sent to school leaders in advance of their interviews on planning tools and practices. This document includes the "infrastructure" section of three separate planning tools as well as a description of the general structure and aims of the tool.

Appendix F: Planning Tool Samples Sent to School Leaders

(1) Full descriptions of varying levels of readiness for technology implementation

TECH READINESS		NEEDS IMPROVEMENT	SATISFACTORY	GOOD	EXCELLENT
Infrastructure	*Bandwidth*	Wireless Internet exists at the school, but there is not enough bandwidth for all students to be online at the same time.	Wireless Internet can support all students online, but slows when students access other media content (videos, music, etc)	Wireless Internet supports all content-creation and media activities, but is reaching 100% of capacity.	Wireless Internet supports all content-creation activities and has excess capacity for adding additional devices.
	Access Points	Wireless access is spotty throughout the school building because of a lack of access points.	There is an access point in every other classroom.	There is an access point in every classroom, and at least one in the larger learning areas (library, gym, etc).	There is an access point in every classroom, and multiple access points in the larger learning areas (library, gym, etc).
	Network	No consideration has been given to how to keep students on the school network. They can access inappropriate content.	Inappropriate content is blocked and consideration is given to blocking other "distracting" sites.	Inappropriate content is blocked and other sites (such as social media sites) are considered individually and blocked (or not).	Access to sites is consistently monitored, re-evaluated, and updated in terms of the needs and wants of teachers and students.

(2) Descriptions of team readiness levels for discussing and making changes to prepare for technology

	The team would not be prepared to discuss this strategy at this time and would need considerable preparation to do so.	With some additional minutes of time and research, the team could conduct a comprehensive discussion.	The team is confident that it could enter into a comprehensive discussion at this time
Discuss a variety of options available to districts to ensure that appropriate internet-ready technology devices are available to support teaching and learning.			
Discuss the elements and implementation of a robust, responsive, and safe network infrastructure.			
Discuss the elements of a positive, effective, service-oriented technology support system.			
Discuss a comprehensive, environmentally sound cycle for review and replacement of technology software, hardware, and infrastructure.			

(3) Current reality assessment with descriptions of recommendations for technology implementation

CURRENT REALITY:

Select your implementation level for each recommendation in the columns provided.

Summary of Recommendations for the Local Education Agencies: *AZ Long-Range Strategic Ed Tech Plan, 2009*	Already Implemented	Currently Implementing	Planning for Implementation	Not Implementing
Develop and implement new strategies and practices for the funding, purchase and support of technology infrastructure and services.				
Provide a 1:1 learning environment for 6th-12th grade students and at least a 3:1 ratio for students below 6th grade. (ETAC has avoided using "computer to student ratios" because other digital learning devices, i.e. net books or smart phones, might describe these ratios)				
Maintain an internal wide area network that provides connections from the district to each school and between schools of at least 100 Mbps per 1,000 students/staff within the next one to four years and at least 1 Gbps per 1,000 students/staff within the next five to seven years. (Adapted from *High-Speed Broadband Access for All Kids)*				
Provide and maintain an infrastructure for				