Administrative Perspectives on the Implementation of One-to-One Computing

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Abstract

School leaders from eleven middle and seven high schools implementing ubiquitous computing programs in the United States, participated in focus groups in 2011, providing insights into strategies for successfully integrating laptops into their schools. Advice was sorted into three major themes that can be used by future administrators tasked with planning ubiquitous computing initiatives: program planning and leadership (policies, procedures); infrastructure planning (networks, software); and promoting teacher motivation and buy-in.

Keywords

One-to-One Computing; 1:1 Computing; Ubiquitous Computing; Technology Leadership; Program Planning

Introduction

One-to-one computing programs seek to improve educational opportunities by giving every student or requiring every student to buy a laptop, tablet, or mobile computing device for use in their studies. Worldwide, many educational institutions have tested 1:1 computing programs with mixed results. To maximize the potential of 1:1 computing, new challenges must be understood and managed by those most commonly responsible for its administration--principals, technology directors, technology facilitators, and media coordinators.

Between 2006-2010, eleven middle schools and seven high schools in the U.S. state of North Carolina, began new ubiquitous computing programs with funding support from the state. This paper presents findings from a study of administrative teams at these schools, providing important lessons learned about program planning and leadership, infrastructure planning, motivating teachers, and promoting program buy-in. The results provide useful insights into 1:1 leadership to aid others planning to implement similar programs.

Background Literature

Literature on 1:1 leadership suggests school leaders must be prepared to take on multiple roles in preparing for and implementing ubiquitous computing, including such roles as learner, motivator/change agent, technician, instructional leader, purveyor of resources, and evaluator. Failure to tend to one role can impact on another. For example, a principal who has not learned about technology integration may be a less effective instructional leader, or a technology director who does not build a sound technical infrastructure may not be able to motivate buy-in among teachers.

The first role 1:1 leaders need to embrace is that of learner. Research has shown committed 1:1 leaders can positively influence program implementation through varied policies and actions (Shapley et al., 2010). However, there is a need to prepare school leaders for implementing 1:1 programs and 21st century schools as much as teachers and students (Fletcher, 2009; Shapley et al., 2010). Flanagan and Jacobsen (2003) caution, "very few principals have themselves used computers in meaningful ways with children, and therefore lack the requisite pedagogical vision and experience to guide teachers" (p. 127). Fletcher (2009, p. 22) adds, "When leaders are clueless about technology and the impact it can have in classrooms, they are powerless to change their school or district into one that provides tech-enabled instruction for students."

Fortunately, efforts by colleges, technology organizations, and state departments of education, are beginning to focus more on administrator preparation for leading technology initiatives. For example, Ertmer et al. (2002) reports on a professional development course on technology-enhanced learning environments taught to seven school principals and

one technology facilitator, noting school leaders came to a better understanding of technology leadership by learning about technology integration and "strategies needed to support teachers' efforts" (p. 13). Fletcher (2009) reports on the Principal Technology Leadership Institute (PTLI) in the U.S. state of Illinois that trains school leaders on technology skills and integration, and using data in decision making. He also describes the approach to leadership development among participants in Maine's laptop initiative, where principals, technology facilitators, and lead teachers learn together in semi-annual workshops. Leadership learning can also be informal. A common recommendation in 1:1 literature is for leadership teams to visit and learn from other schools in their area implementing 1:1 programs (Peterson, 2008).

Other roles 1:1 leaders must hold include motivator and change agent. They must be prepared to communicate a vision for their program to motivate stakeholders (Chang, Chin, & Hsu, 2008; Maninger & Holden, 2009; Peterson, 2008; Shapley et al., 2010), but they also need to involve school staff and community members in decision-making committees and build consensus as to what a given school values most about 1:1 computing (Chang, Chin, & Hsu, 2008; Flanagan & Jacobsen, 2003; Shapley et al., 2010; Weston & Bain, 2010). Shared values are critical, as a school culture focused too heavily on student monitoring, discipline, and rules, could dissuade some teachers from adopting new technologies (Drayton et al., 2010). Sclater, Sicoly, Abrami, and Wade (2006) reported secondary teachers were reluctant to adopt 1:1 computing when mandated from external administration, and recommended such major change initiatives originate within the school and involve teachers. To inspire instructional staff, technology leaders should "model technology use in presentations [and] electronic communication of daily bulletins" (Flanagan & Jacobsen, 2003, p. 134). Leaders can also use tools like Google Docs to inclusively survey teachers and invite ideas and feedback on 1:1 program implementation (Fletcher, 2009). Leaders need to convey patience with teachers and recognize that change takes time (Cutter, 2006; Maninger & Holden, 2009), but they must also promote risk-taking among early technology-adopting teachers to build capacity within the school for ever-increasing levels of technology integration (Flanagan & Jacobsen, 2003).

Technology leaders need a sound understanding of technical issues and need to work with staff to plan for technology purchases, deployment, service, and replacement (Flanagan & Jacobsen, 2003). Otherwise, as Bebell and Kay (2010) report for one pilot 1:1 school with poor "management and oversight," technology use among students and teachers may be less than in effectively managed environments (p. 51). Instructional staff is dependent on reliable networks in 1:1 environments, since students commonly access online resources (Penuel, 2006). Hence, technology leaders need to understand technical infrastructure options around networking and file management (Flanagan & Jacobsen, 2003), work to establish a dependable infrastructure (Chang, Chin, & Hsu, 2008; Peterson, 2008; Shapley et al., 2010) and provide for adequate technical support (Shapley et al., 2010). Flanagan and Jacobsen (2003) caution that leaders who don't understand infrastructure options may yield to school technicians who too often deploy restrictive networks that become barriers to teacher and student use. It is also recommended that school leaders seek computer vendors willing to provide high levels of support (Peterson, 2008).

Another critical role for 1:1 leadership is that of instructional leader. In the long term, school leaders can influence technology use in the classroom by screening for and recruiting teachers who are technology-savvy or willing to learn and innovate for kids (Cutter, 2006). On a daily basis, 1:1 principals and superintendents need to provide expectations for teacher technology use, and outwardly convey the importance of technology use, putting some pressure on teachers to make use of new tools (O'Dwyer, Russell, & Bebell, 2004; Shapley et al., 2010). Technology leaders need to arrange for teacher professional development focused on technology integration, and include teachers in decisions about professional development topics (Chang, Chin, & Hsu, 2008; Cutter, 2006; O'Dwyer, Russell, & Bebell, 2004; Shapley et al., 2010). Effective technology leaders encourage collaboration and time for co-planning among school staff (Cutter, 2006; Shapley et al., 2010; Warschauer, 2005/2006). It is also recommended that 1:1 leaders learn alongside instructional staff (Flanagan & Jacobsen, 2003). Technology training for inexperienced parents and community members could also be included in the mix of professional development (Flanagan & Jacobsen, 2003).

One-to-one leaders must often take on the role of purveyor of resources, including capital, human resources, technology, physical spaces to extend the

learning environment, and digital learning resources. Warschauer (2005/2006) cautions leaders to consider the "total cost of ownership" as laptop initiatives involve not only initial hardware purchases, but also such items as replacement hardware, supplemental hardware (e.g., projectors, printers, digital cameras), software, and technical support (p. 36). Leaders must often garner community resources and business support to sustain costly technology initiatives (Flanagan & Jacobsen, 2003; Maninger & Holden, 2009). It is recommended that administrators acquire teacher laptops in advance of full-school deployment, to give teachers extended time to plan and change materials (Cutter, 2006; Maninger & Holden, 2008). Flanagan and Jacobsen (2003) recommend administrators expand school hours, so learners without Internet access at home can more equitably utilize their laptop for learning before or after regular school hours (Flanagan & Jacobsen). It is commonly recommended that 1:1 leaders arrange student and teacher access to technology-based educational resources (Shapley et al., 2010). In a synthesis of research on 1:1 computing, Penuel (2006) reports that teachers who perceived adequate access to subject-specific digital content were more likely to utilize laptops in their classroom. Hence, principals may need to ensure a school's laptop program includes budgetary support for content subscriptions or human support from technology facilitators or content specialists who can synthesize and share with teachers freely available online instructional content and tools.

A final role technology leaders must take on is that of evaluator. It is generally recommended leaders monitor a program "to determine the extent to which it is (or isn't) enhancing the learning environment" (Maninger & Holden, 2009, p. 9). Evaluating school technology was one of the factors Taiwanese teachers associated with technology leadership in a study by Chang, Chin, and Hsu (2008). Effective leaders may be involved in evaluating such items as how well school staff are utilizing technology, how well the school technology plan has been implemented, how well purchased resources align with content standards, or how student learning compares to technology costs in cost-benefit analysis (Chang, Chin, & Hsu, 2008). Principals should consider partnerships with faculty at local universities who may be willing to collaborate on evaluation projects that involve teacher/student surveys at a minimum (Warschauer, 2005/2006).

Methods

Evaluation Questions

The findings presented in this paper are drawn from a comprehensive, mixed-methods evaluation of a pilot project of ubiquitous computing in the U.S. state of North Carolina, examining student, teacher, and administrative reactions to the innovation. This study outlined in this paper is a subset looking at administrative perspectives and answering the question, *what recommendations do school administrators involved in ubiquitous computing programs provide to assist other leaders with implementing similar initiatives?*

Participants

Eleven North Carolina middle schools began ubiquitous computing programs with funding support from the state in the 2006-2007, and 2007-2008 academic years. Seven North Carolina high schools began ubiquitous computing programs with funding support from the state in the 2008-2009 and 2009-2010 academic years. The administrative teams at these schools represent the participants for this study. Administrative teams include the school principal, the district-level technology director instrumental in infrastructure planning, and school-level technology facilitator and media coordinator pairs (tf/mc pairs) instrumental in instructional support.

Data Sources

While multiple data sources were employed in the overall evaluation (e.g., student surveys, teacher focus groups, administrative focus groups), the sole data source utilized in this focus study was administrative focus groups. Specifically, nine separate focus groups were held in the spring of 2011, with all high school principals, all middle school principals, all district technology directors, and six tf/mc pairs from the high schools. The principal and technology director focus groups were held during an administrative planning retreat, while the tf/mc focus groups were held during individual school site visits. No middle school tf/mc focus groups were held in spring 2011, since the evaluation focus at that time was primarily on implementation by high schools newer to the program.

A focus group protocol was prepared internally with separate questions for the three groups: principals, technology directors, and facilitator/coordinator pairs. The open-ended questions were designed to elicit feedback on topics of interest to the evaluation team and state-level educational technology staff. An

evaluation team consisting of university faculty and research associates conducted focus groups. One university researcher was responsible for analysis as described. Focus group topics and questions included the following:

Implementation and Vision: How have your visions of 1:1 computing evolved since the actual implementation? How have your school and district visions for 1:1 computing evolved together? What are some strengths and weaknesses of your districts' 1:1 deployment models, and what would you change about your models? Can you describe how school leaders have cultivated an environment that promotes innovation?

Infrastructure: How have you addressed the need for file storage for students and teachers? What has been done to decrease any issues that have arisen due to the increased use of the wireless network? What types of software have you purchased this year or plan to purchase in the future? How do you determine what will be purchased? What has your school district done to increase the efficiency of the filtering software, and to ensure students are unable to override the filtering system?

Training and Support: What type of technical assistance do you have in place for teacher support and what else is needed? What do you think is the most important source of technology ideas for teachers in your school (professional development, subject area teams, mentors, technology facilitators)?

Buy-In: What has emerged in your 1:1 programs that either facilitated or hindered teacher buy-in of 1:1 computing?

Teaching: Have you seen any changes in the types of learning activities students are involved in since beginning the 1:1 program (e.g., student-directed research, group work, project-based work, communicating with peers)? Do you think some teachers are reluctant to let go of traditional roles (lecturer) and take on new roles (facilitator) for fear of students not learning content and testing well? Do you think some teachers are reluctant to adapt instructional practices for fear of students not being able to handle increased academic responsibility and higher-level thinking?

1:1 Best Practices: Leveraging what you have learned thus far during your deployment, what would you suggest for other schools considering a 1:1 environment?

Analysis

The focus group discussions were recorded and later transcribed. All transcripts were imported into *Atlas.ti* software for qualitative analysis. Transcripts were open coded, consistent with grounded theory (Charmaz, 2008), which is a process of building theory from data rather than using pre-existing theory as the basis for traditional research. Each transcript was coded in turn (e.g., principals, then tech directors, then TF/MC pair #1), rather than coding similar questions across transcripts. This approach was considered more inclusive, since coding issues around a specific question might lead a coder to miss issues unrelated to the question but important to topics discussed elsewhere. Individual codes were generated first (e.g., communication-from admin).

When similar codes emerged, they were grouped categorically using a similar lead-word (e.g., communication-teachers to home, communication-school to district). Through this process, categories were generated for further analysis (e.g., communication in general). After first-round coding and category generation, text segments under categories were re-read and further sorted into themes. For example, the category communication was ultimately split into multiple themes, with some of the quotes fitting better under the theme of program planning (i.e., need for communication from administration to stakeholders, need for communication from teachers to technical support staff) and some of the quotes fitting better under the theme of infrastructure planning (i.e., pre-selecting appropriate communication software to support student-teacher and teacher-parent communication).

Major categories generated during analysis included: access, buy-in, buy-out, change, communication, decisions, deployment, equipment, expansion, fear and anxiety, mindsets, motivation, professional development, planning, pressure, software, students, teachers, teaching, and tech support. As explained, these categories were examined further with embedded issues ultimately sorted into three emergent themes: program planning and leadership (policies, procedures), infrastructure planning (networks, software), and promoting teacher motivation and buy-in. Study results are organized by these three key themes.

Theme 1: Program Planning and Leadership

Program planning is a complicated process involving leaders, stakeholders, and committees, who deal with varying policies, plans, and models, and invest considerable time prior to actually deploying laptops in a school. Eight essential elements of program planning are outlined below, based on focus group feedback. Future schools starting 1:1 programs can use these essential elements to prepare a more effective deployment. Study participants generally recommend these elements be completed before laptops ever land in student hands.

Establishing Planning Teams and Keeping Stakeholders Informed

Two of the first steps in planning a 1:1 program include establishing planning committees to manage key aspects of the deployment, and setting up communication channels to keep primary stakeholders such as teachers and parents informed.

In the technology director and two tf/mc focus groups, participants emphasized the need to involve multiple stakeholders on different planning committees, including community members:

> *Get all the stakeholders involved from day one. We started with just ITS and administrators... and we learned very quickly that we needed teacher input.... we started having those weekly planning meetings with everyone, not just the people who would be directly responsible for making it happen....*
>
> *I had a huge advisory committee and tried to bring in not just parents, but the public library and the community college, the people that I thought were the most impacted by the kids having laptops. And that helped us get our community [involved]....*

One commonly mentioned in-school planning structure was a media-technology advisory committee (MTAC) consisting of school and district leaders, media coordinators and technology facilitators, and lead teachers from each department. One-to-one planning committees in the same district were encouraged to meet cross-school to ensure a consistent implementation under the same district infrastructure, and to share information cross-district to learn from other programs.

Planning teams were involved in varied work roles such as assisting with laptop distribution on deployment days, and providing support for student laptop use. The most common role discussed, however, was conducting research into other 1:1 programs, to avoid "re-inventing the wheel" or over-spending on unnecessary resources. Technology directors recommended planning committees take advantage of the 1:1 computing checklists and planning guides published by organizations such as Intel. Principals discussed being actively engaged in researching the best 1:1 format for their individual schools by visiting and teleconferencing with other schools (e.g., laptop carts, take-home laptops). Focus group participants cited several ideas they picked up through research, such as proper setups for dependable internet access, best practices for orientation, what to include in policy statements, which laptop bags to order to protect equipment, and what software tools were most useful and cost-effective (e.g., Schoolology):

> *We know there are other colleagues now that we can call on. ... So that's why I encourage, for example, our tech facilitator to go out and see what other folks are doing. ... see if we can't do it better. And we take what they're doing and try to take it to the next level.*

As planning teams begin to make key decisions, it is important to communicate those decisions to stakeholders to avoid confusion and limiting buy-in for 1:1 programs. In two technology facilitator/media coordinator focus groups, participants discussed the importance of communication to key stakeholders:

> *When it originally started, the people that were here kept it in a box.... Everybody wasn't completely informed about what was really going on, and now it's an open book. We have a huge Web site... we've made it as transparent as possible. That's really important--the communication.*

As noted, Web sites were reportedly used to communicate key decisions and information. Also, one high school principal reported using a staff intranet to store meeting documentation, including wiki pages and audio recordings of meetings captured with the free *Audacity* software on teacher laptops.

Establishing Usage Policy

A common step in program planning is to establish an acceptable use policy (AUP) for laptops and networked resources with the involvement of key stakeholders, including students. One high school principal described getting students involved in creating an acceptable use video at their school, and showing the presentation to parents and other students at orientation meetings before deployment.

Acceptable use policies contain statements of what can and can't be done with a laptop and networked resources, as well as penalties for not following rules. One high school principal, for example, indicated that students were not allowed to use proxy Web sites to bypass school filtering systems. If caught breaking this rule, student laptops were confiscated for two weeks. Two schools reported policies that discouraged students from using school e-mail accounts to send out mass or chain emails, engaging in cyber bullying, and using messaging software such as *Skype*, *AIM*, or *Google Chat* during class time. Schools also recommended acceptable use policies include expectations with regard to copyright protections and academic honesty.

The technology directors noted it was important to have acceptable use policies and to remain consistent in enforcing the rules. However, they suggested the policies themselves should be flexible enough to allow some usage differences across classrooms (e.g., some teachers may want students to pull out their laptops when they first enter a classroom, while others may want students to wait for direction).

Selecting Security Options

Security options include a school's plans for insuring and protecting laptops against damage, misuse, and theft. In the district technology director and high school principal focus groups, participants discussed different models of insuring laptops against theft and breakage. Most schools charged parents an administrative use fee of $25 per laptop to help pay for insurance, and to buy maintenance items such as new batteries. Some schools had parents sign waivers agreeing to be responsible for the equipment if their child broke or lost their laptop by paying a $50 insurance deductible. One high school principal described a policy in place at their school where a student with a broken laptop would be given a loaner laptop to use in-school only for a limited period of time (~30 days). Their parent(s) had to pay the insurance deductible during that time, or the loaner would eventually be taken away--the concern being a student who broke a laptop through negligence would just continue to use the loaner and not meet their financial responsibility for repair.

One of the more common breakage issues reported in focus groups was cracked screens when students placed a laptop in a backpack already overloaded with books, placed a pencil on the keyboard before closing it, or didn't use a hard case for protection. One technology facilitator recommended not investing in laptop backpacks which tend to get overloaded with books and papers, but instead buying students a separate, smaller, laptop-only bag that can't be overloaded with materials.

To prevent issues with students picking up someone else's laptop, since most laptops in a 1:1 deployment look the same, technology directors and one tf/mc pair noted the importance of labeling laptops with either a big name tag or an individual bar code. One tf/mc pair recommended bar coding laptops into a circulation system for more efficient deployment, as opposed to keeping records manually in a spreadsheet. In the technology director and high school principal focus groups, participants discussed the need to place tracing software such as *Computrace* on laptops, so if they are reported stolen and later connected to a wifi network, they could be traced and recovered by police. One technology director believed the presence of this software was a deterrent to theft.

One tf/mc pair discussed planning for software services such as *Active Directory* or *Deep Freeze* that get installed on student laptops before deployment to restore laptops to system defaults and applications upon reboot. Such software helps maintain clean terminals with fewer viruses and file-related issues, although participants noted such software is a training issue for students and teachers who may be used to storing files on desktops. When a laptop gets wiped clean daily, students and teachers must learn to use flash drives or other online storage solutions for their files.

Creating a Deployment Model

Procedures for within-school deployment must be planned and focus group participants described a number of hybrid deployment models that worked better for their individual cases: a testbed model involving classroom carts first, a tiered model involving single grade levels as pilots, and an early adopter cohort model involving teacher teams as pilots. In one focus group, a suggestion was made to give laptops to teachers a year in advance of student deployment, giving teachers time to pick up skills and begin changing their classroom materials.

Some high school principals and tf/mc pairs suggested there could be advantages to deploying laptops in carts first before deploying laptops to individual students. Cited advantages include: giving teachers

time to try out a few projects without reworking their entire curriculum, reducing teacher and student anxiety and building their self-efficacy, preparing students in basic procedures such as logging on and off a network and working within filter restrictions, and allowing teachers and school staff to develop and cite examples of quality usage when talking to parents in orientations about how their children can benefit from laptops:

> *We had the freshmen use laptops out of carts in the early part of the pilot. We assigned a cart to each participating teacher's classroom. The freshmen did not take home the laptops ever, but they had full access to a laptop in every teacher's class. This allowed us to work out a number of bugs before we started letting them take them home.*

A second partial deployment plan discussed by high school principals and some tf/mc pairs was to deploy to only one grade level initially as a pilot test, to identify and work out issues before full deployment to a school:

> *… for year one I think it was very helpful that we targeted one particular group to deploy to so that we could learn what we did right and what we did wrong in a small setting as opposed to a full school deployment. We now know through experimenting with the freshmen as a pilot group what we can do a little better and what we did excellent to start with....*

A third partial deployment plan described by a tf/mc pair involved deploying to teacher teams who were trained together and took time before deployment to plan instruction with laptops:

> *We had three of them who became our test group for early implementation within their classroom…they had the training and then they came back and sat and planned how they wanted to bring these computers into their classroom and change instruction.*

Eventually, most schools issued laptops directly to students, although one school opted to continue using laptop carts. Cited advantages of carts included: avoiding problems with students forgetting to bring or charge their laptop; and reducing stolen, lost, and broken laptops:

> *If I had my own personal vote, they'd go back in the carts next year before they get torn up for one more year and then the warranty expires.... Just looking at a sustainability perspective, we're already on that cusp of not being able to hand them out one per student next year! ... We're looking really closely at whether the kids need them at home....*

Cited disadvantages of carts included: trouble siting carts in crowded classroom, the need to upgrade school electrical systems to plug-in 500-1000 laptops every night, and decreased opportunities for extended learning in the home.

Siting Laptops Prior to and After Distribution

Deployment at the beginning of a school year and reverse deployment at the end of a school year are intensive events that must be planned in advance. In the technology director and two tf/mc focus groups, participants discussed making plans to physically site hundreds of laptops prior to their distribution to students (e.g., in the school gymnasium, cafeteria). Participants noted the need to secure a large space for receiving hundreds of laptop boxes, as well as garbage services to pick up boxes and packaging materials once the laptops were unpacked.

During the school year, laptops for day users or other loaner laptops must be housed in a physical space for check out. Likewise, any laptops taken up from students and stored over summer months must also be physically housed. One tf/mc pair described converting a classroom to a help desk with shelving for undistributed laptops to reside and for day users to come and check out a laptop for day use. At this school, storage needs were noted to receive laptops at the end of the school year when they were returned to inventory.

Creating a Training Plan

Another element of 1:1 program planning is training or professional development. Teacher training is an obvious need, and one that is described later in this paper. Less frequently discussed is the need to train other stakeholders in a 1:1 program. The middle school principals discussed the importance of training school leaders to use emerging tools, so they can understand what is happening in classrooms and model appropriate uses. One tf/mc pair suggested school technical support staff receive training on teachers' needs in a 1:1 program, since there can be a disconnect when tech support does not understand classroom needs or instructional problems, only technical problems:

> *It would be nice for the IT department, the people that are not in the building, if they could also have some*

> *training too, because I think it would help them see through a different lens. Like what teachers need in a one to one. What has to happen?*

A different tf/mc pair indicated their tech support staff were trained to troubleshoot and make minor repairs on computer systems (e.g., HP, Dell), to avoid shipping laptops out for repair.

In all but one focus group, participants discussed the need for student training on technology. In the high school principals' focus group, participants noted teacher concerns over a lack of student skills when implementing 1:1 initiatives. Two school leaders cited findings from their schools that would suggest a minority group of students (around 20%) may have a need for very basic keyboarding and computer skills training:

> *I tell you one thing we found that was interesting on this last survey. You assume, because kids, 21st century kids, do Facebook, they can do all these things on the computer. You're assuming they're digital natives, they can do certain things. We find 20% of our kids are kind of illiterate as far as how to do certain things on the computer.*

In two tf/mc focus groups, participants also mentioned students may lack not only technical skills, but also critical thinking skills to use social networks and Web sites safely and appropriately:

> *We have some students who are still learning how to use the social walls... we had a group of kids who [entered] their email address as their Facebook address. So they got all these crazy Facebook things, and then I had to educate them... don't do that.*

Focus group participants suggested covering several key topics during student orientations, including: caring for your laptop, acceptable use handbook items and legal responsibilities, and logging in to make sure everyone can access their machine. Focus group participants indicated that student learning about topics such as these took at least two forms: formal face-to-face training delivered in the classroom or school media center, and more informal teacher-to-student and peer-to-peer teaching.

Creating a Technical Support Plan

Focus group participants frequently discussed an increase in technical support needs brought about by 1:1 laptop programs. As one example of an emerging technical support need, technology staff reminisced about the ease with which technical support staff used to install plug-in's and software in computer labs and on laptop carts. In a 1:1 program, however, staff had to track down 20-30 individually distributed laptops to load one software program or one plug-in for a class:

> *On the technical end, our techs have been reporting to us that when a new plugin needs to be installed, it was very easy for them to go into a teacher's classroom during their planning period and install that plugin on all 30 computers [on a mobile laptop cart]... but now they have to track down individual students....*

Not surprisingly, one tf/mc pair noted there needs to be good communication to technical support staff the summer before a fall laptop deployment, so they know how to prepare machines--with specific software, labels, etc.

In the middle school principal and one tf/mc focus group, participants reported anxiety among school technical support staff related to pending laptop programs and the need to manage hundreds of laptops. Participants reported staff being overwhelmed by work and unable to keep up with school requests for day-user checkouts, broken laptop repairs, software installations, removing filter blocks, etc. No solutions were offered to alleviate this workload other than hiring more personnel or examining policies that would distribute some technical support duties to regular users, so staff and students don't end up waiting on backed-up technical requests:

> *Our high school is almost 600 students, and then we have two elementary schools, so all of that with just three IT people. ... I mean because if something happens and I can't get something loaded on my computer and I need, I'm shut down until somebody gets over there, and there's every other school doing the same thing.*

Schools reported receiving technical support from a variety of sources. A few schools reported hiring full-time technical assistants, but this position was not available in every school. One middle school principal discussed a plan to promote more peer-to-peer help in the face of limited technical support:

> *We developed something called tech buddies. We took our speed boaters and those people that were far in advance and made them tech buddies. So during your planning period if anybody has issues that we can't get to one of our main people, then these are folks you can call upon to help.*

Synchronous and asynchronous technology tools such as *Skype* and *Google Docs* can bolster peer-to-peer support as teachers can seek immediate help from peers or archive questions other teachers can field when time allows:

> *Every teacher is on Skype ... we use it for instant messaging throughout the building. So lots of, "Hey come here... I need you." That's really made things a lot more efficient than in the past. And one recent thing is where our tech facilitator made a spreadsheet on Google Docs that everybody can get on, and people put issues that can't be resolved immediately on there and everyone can get on there and look and say, "Oh, well I can fix that. I'll go help her during my planning." I'd probably say 70 percent of what's on there the tech facilitator handles.*

Another middle school principal reported setting up a procedural chain for help requests, with questions fielded first by peer teachers, then by the school technology facilitator, and finally by district technical support staff:

> *We get em in like three different stages. ... We have a high flyer teacher who does the first stages. If that doesn't work, we go to a tech facilitator. If that doesn't work, we end up to an IT person. And that's kind of how we handle it.*

Almost every school discussed use of a physical help desk. In some districts, the help desk was a district-level entity removed from the 1:1 school and staffed by the district. In other districts, however, the help desk was actually in the 1:1 school, and scheduled and staffed with various school personnel and/or advanced students to field technology problems. Four tf/mc pairs and both middle and high school principals discussed using advanced students as technology interns or school help members to help field technical problems. However, those planning 1:1 programs should be aware that not every teacher may be comfortable asking for or receiving technical help from student users. One middle school principal discussed the need to change teacher mindsets that it was okay to ask students for help:

> *Most of [the teachers] have finally bought into the idea that we are kind of a learning community, and if a student comes up with an original idea, that's ok, that the idea the student has may work. An idea that a fellow teacher has may work. And that's not a mindset that we had a year or two ago. No student was ever going to teach a teacher anything, but that's kind of changed and it has to with technology. We all have to learn from each other.*

One issue that emerged in focus groups with regard to technical support was the use of school technology facilitators to provide technical support. At least one district technology director and a few middle school principals reported their instructional support staff fielded technical support problems, on top of their primary role of assisting with instruction. In the district technology director and high school principal focus groups, participants noted it was important to plan for real technical support, so the technology and instructional facilitator could focus on supporting instruction and not "fixing" computers:

> *Our vision is we didn't want to lose an instructional technology facilitator to become a fix it guy. ... But we have a student help desk. We also have a technology assistant who is assigned to the building ... so that an instructional technology facilitator can truly be an instructional technology facilitator in the classrooms for kids.*

Creating a Sustainability Plan

In the middle and high school principal focus groups, and one tf/mc focus group, participants discussed sustainability; suggesting schools are worried about sustaining costly 1:1 initiatives and must plan in advance for funding sources to maintain a consistent level of implementation. Participants discussed the need to fund future laptops, professional development, and supplies (e.g., bulbs for Smartboards), to keep their initiatives running. High school principals discussed looking for external grants to sustain their initiatives. Participants noted teacher concerns over wasting time by changing all of their lessons to incorporate technology, only to find out later the technology would be removed from the school because it was not sustainable. Teacher buy-in could be hindered if school leaders do not articulate a vision to teachers for how the 1:1 project is sustainable over time:

> *My biggest area of concern ... comes back to funding and perpetuation, and the only thing that it has clarified is that it may be very difficult for us to perpetuate the program.... If we did not have full warranty on these machines, it could be very expensive to maintain. As soon as our warranty expires, unless we find another grant, or the district finds a pot of gold ... we're real concerned about how the school might be in a position to support a program like this.*

Theme 2: Infrastructure Planning

Aside from the policies, procedures, and models previously discussed, schools also reported a need to complete advance planning for their technical infrastructures with factors such as Internet access, file storage, filtering solutions, advance software purchases, and supplemental equipment purchases. Failure to tend to any of these critical infrastructure pieces in advance of deployment could hinder the effectiveness of a 1:1 program.

Planning for Internet Access

Internet access was a key issue discussed in nearly every focus group. Participants primarily discussed access in the school, while access in the community and in the home were mentioned less frequently. Regarding school-based access, participants in four focus groups indicated their school's wireless access had appropriate bandwidth to access resources as well as sound dependability so as not to discourage teachers from using Web-based resources and tools:

> *Most of those access points went in toward the end of last year ... we have not had any complaints from teachers about being knocked off the network this year, and that was a pretty frequent concern last year.*

Schools with sufficient wireless access reported adding further access points and stronger radios to bolster signal strength. One school reported 98 different access points, and another an access point in every classroom. At least one school reported using external technical consultants to help them properly upgrade their infrastructure.

Participants in three schools indicated access was somewhat problematic in specific places (e.g., the gym, out-buildings/trailers, school library), but otherwise fine. Participants in two focus groups indicated their schools were still facing problems with wireless access. Focus group participants from three different schools believed undependable networks and Internet access would lead to teacher frustration, highlighting the importance of a solid infrastructure. Participants from two schools suggested undependable access was a management headache for teachers who might have to change technology-enhanced lessons at the last minute. Rapidly responding to technical issues was recommended to offset teacher frustration:

> *I think that any other school that looks at this should make sure that they have... already in place or they have the funds to bring on more IT people. Because when teachers get frustrated and they can't use their technology... that hurts buy-in a great deal.*

In terms of community access, one high school principal indicated they had researched free community wifi options for students without access in the home, and notified students of these options, including wifi in public housing developments and community centers. In two districts, students were using free wifi in public libraries and restaurants such as McDonald's, as partial evidence that community-based access is utilized to an extent.

Two schools reported home access was problematic for rural students and teachers because of slow or no access. In response, one school allowed users to access their wifi network in the lunch room after school hours.

Creating a File Storage Plan

A common theme among schools was file management issues for students and teachers alike. Schools reported at least three different possibilities for teacher and student file storage, including local servers, flash drives, and cloud computing.

Some schools maintained their own servers and provided storage space for teachers and students--both public folders for temporary storage, and private folders for personal storage. Several sites reported problems with local servers filling to capacity. For example, one school decided to synchronize student machines with a server whenever students logged into the network in order to backup saved work, but they eventually had to remove synchronization when video, music, and data files filled their server to capacity. One tf/mc pair mentioned a need to set limits on storage such as a half gigabyte per account.

In many instances, students were described as using USB flash drives to save or backup files in a location external to their laptops. One school went so far as to use *DeepFreeze* software to wipe student machines to default settings and programs whenever rebooted, requiring students to save files externally to flash drives or servers.

Participants in four focus groups reported on-campus storage solutions were costly to maintain and expand with a constantly growing need for storage, and thus moved their storage needs off campus to take advantage of "cloud computing" services offered by *Google Apps*, course management systems like *Schoolology* and *Angel*, and Web 2.0 publishing outlets for student projects such as *My VR Spot*.

Creating a Filtering Plan

Based on comments in nearly every focus group, it is apparent that filtering is a complicated process requiring advance planning, software solutions, and new policies. Technology directors discussed purchasing multi-year contracts for four different filtering programs: *DeepNines*, *iPrism*, *M86*, and Microsoft's *Active Directory*. The directors and several tf/mc pairs noted the programs were imperfect and might block too many sites one day, and not enough sites the next. Further, most tf/mc pairs reported students at their schools had found proxy sites that would allow them to bypass school filters, requiring schools to monitor student behavior in different ways to ensure this did not happen. For example, one school reported spot checking student Web history reports for any access to known proxy sites, with another spot checking student Web activity by live remoting into their desktops, and yet another setting up automated notifications to the media coordinator when students searched for blocked words.

Schools reported the need to adjust filter settings related to off-campus network and Internet access. One school reported purchasing a filtering product that would purposely continue to filter when students accessed networks off the school campus. In contrast, two other schools adjusted their filters more liberally to allow students to access public wifi networks when off campus, and to access social network sites such as Facebook when at home but not in the school.

Blocking Web sites was a key issue discussed in many focus groups, with teachers reportedly frustrated by filters that prevented them from accessing and using educational resources. One tf/mc pair noted their school had purchased a product that would filter differently based on laptop, with teacher laptops able to access more sites than student laptops. In three other focus groups, participants noted decisions had to be made with regard to who could change filter rules and for how long. One school employed an *iPrism* feature giving teachers a login with rights to override a particular blocked Web site, with that domain then available for up to an hour on the teacher's laptop only. In two other schools, all requests to unblock filtered sites had to go through a single person at the school or district level, but the success of this approach is largely site dependent:

> *It's a horrible process to get something unblocked…And teachers get frustrated....*
>
> *I've been pleasantly surprised and pleased that… We just email one of the tech people and usually within ten, fifteen minutes it's unblocked as long as that person is available.*

Selecting Software for Whole-School or Targeted Deployment

Software is another key infrastructure element that must be planned in advance of deployment. Two tf/mc pairs noted software decisions are often made at the district level, because software programs such as course management systems have to be rolled out to multiple schools. One tf/mc noted it is important for any stand-alone 1:1 schools to have a mechanism to communicate their unique software needs to the district level. In this section, software discussed in focus groups is summarized by users, to give an overview of the types of software that must be considered in advance of deployment for a range of different groups.

Focus group participants noted program stakeholders used a variety of software tools to plan and implement their programs. For example, technical support staff took advantage of programs like *Destiny Asset Manager* (Follett Software) to help maintain equipment inventory and *Computrace* (AbsoluteSoftware) to help trace or track down any lost hardware. Schools used *Audacity* audio recording software to keep records of meetings, blogs to distribute 1:1 program information and visioning statements, discussion boards to engage staff in curricular discussions, *Google Forms* to solicit input from the community on the 1:1 program and from faculty on software needs, and wikis as a forum for teachers to ask instructional and technical questions of one another.

Teachers were reported to use a variety of software tools for instructional presentation and support. The free Web page editing tool *Weebly* was a popular choice for creating instructional materials. Likewise, in nearly every focus group, participants noted teacher uses of course management systems for posting lessons and homework assignments, creating and distributing quizzes, maintaining online gradebooks that parents could access from home, and supporting online discussions. Course management systems used by schools included *Angel*, *Moodle*, and *Schoolology*, with schools mainly interested in open source systems provided for free:

> *The learning management piece, the Angel piece... has provided the constant consistency of instruction that*

we never had, and it crosses subject matters, departments. ... And I don't think we could have changed teachers' pedagogy ... the types of instruction that they're doing without that learning tool. It definitely forced their hand to change the things like the discussions.

We're using Schoology...the thing that changed with the instruction management piece more than anything is the home-school communication. Because the parents and the students could all of a sudden see everything that they were supposed to be doing.

Teachers were also reported to use a variety of software tools for formative assessment. Online tools such as turnitin.com allowed teachers to check student work for plaigirism, while quiz editors in course management systems and Web-based quizzing tools such as *Quia* and *Quizdom* allowed teachers to distribute online quizzes to students:

The advantage of Quia is that it allows the student to self-pace some review activities and to take quizzes that are automatically graded. So, that worked really well in a one-to-one environment.

Teachers also employed summative assessment tools such as *Classcape* and *MetaMetrics* to track student achievement of state and common core standards.

Focus group participants indicated their students used many different online resources for content and research, including online dictionaries, library databases, ebooks, and Web sites such as YouTube. Schools utilized several online tutorial and interaction programs including *Discovery Education*, *BrainPop*, *Study Island*, and *NovaNet*. One tf/mc pair indicated their students were accessing online college courses, and one middle school principal indicated that students were accessing online courses from the state virtual school.

A final category of software tools used by students was tools for communication and collaboration. Students were reported to use *Gaggle* and *Gmail* for student email accounts, as well as *Skype* for student-student communication and instructor-student communication if a teacher or student was out sick. Students were reported as using *Google Docs* and wikis for an increasing amount of collaboration:

It used to be that to do a group project, you had to get your group together at someone's house... but now I'm seeing a lot more of even the basic stuff being done by Google Docs with everyone at his or her own house, just designating a time they're going to get together online that night and work. ...the teachers are definitely using collaborative projects more. Our teachers are more inclined to use Google Docs and wikis and have kids work together, not just at school, but at home as well.

Uses of social networks for student-student communication were discussed in two tf/mc focus groups, but in both cases, they mentioned such services were blocked at school.

Selecting Supplemental Equipment to Support the Initiative

In a laptop program, there are often supplemental pieces of equipment that must be purchased to assist with instruction. Digital projection was the most commonly mentioned supplemental equipment, ranging from document cameras to interactive whiteboards. A few tf/mc pairs described the need to keep loaner laptops in their inventory for day users or for regular users who simply forgot a laptop at home on a given day. Also, handheld devices were mentioned in association with English and students listening to audio books. Digital video and still cameras were mentioned in association with students creating multimedia and movies as part of projects. Despite the promise of mobile computing, none of the pilot schools in this particular study reported academic uses of these tools.

Theme 3: Promoting Teacher Motivation and Buy-In

Five schools gave a percentage of teachers who had bought into their 1:1 project: 100%, 99%, 93%, 85%, and 65-75%. The school with the lowest reported buy-in also discussed the most technical and implementation/rollout issues that clearly impacted teacher buy-in at that site:

I think, if the question were... what percentage of the faculty thinks that [1:1] has the potential to be a positive... I'd say 65-75%, but... when it comes to who has bought in, I would say zero, not because of the idea, [but] because it's not working.

The data suggest teacher buy-in across these 1:1 schools was sustained by at least five factors: advance work in implementing the state's "IMPACT" technology model, teacher professional development and preparation for unfamiliar roles, teacher collaboration, flexibility for teachers to adapt instructional practice over time (i.e., no administrative

pressure) paired with more palatable pressure from students and peers, and dependability of networks. Future laptop program administrators can plan for similar elements to better ensure teacher motivation and buy-in, and thus more effective uses of integrated technologies.

Previous IMPACT Implementation

Most principals reported one important factor that led to teacher buy-in of 1:1 computing--their schools' work with the state IMPACT technology model prior to deploying laptops. Through their participation in IMPACT, teachers learned to interact with each other and look at student learning and technology uses differently. Tending to such core foundations via a technology model helped to facilitate the changes needed in school culture for successfully rolling out a laptop initiative.

Implementation of the IMPACT Model has been an ongoing effort by the North Carolina Department of Public Instruction since 2003, when the first of four cohorts received funding. Since that time, a total of 43 Title I (low income) schools, clustered in four cohorts, have received funding to implement the IMPACT Model. To date, all four IMPACT cohorts have been funded through the federal Enhancing Education through Technology (EETT, Title IID) program. All schools were required to (1) allocate 25% of their funds to professional development activities; (2) employ both a full-time Technology Facilitator and a Media Coordinator whose time was flexible (e.g., not responsible for teaching a scheduled class) in order to provide leadership in the area of collaboration and technology integration; (3) provide increased teacher/student access to technological resources; and (4) explore, and provide training and support for, strategies to use the technology in instructionally meaningful ways, to increase student engagement and learning.

IMPACT program evaluations (Friday Institute, 2012) demonstrated: positive growth across all IMPACT schools in math end-of-grade test pass rates, with 15 of 19 schools showing double-digit growth, and 6 of 19 schools showing growth exceeding 20 percentage points; positive growth in reading end-of-grade test pass rates, with 17 of 19 schools in the third and fourth IMPACT cohorts showing double-digit gains; increasing technology proficiency among elementary and middle school students; and increasing application of the National Educational Technology Standards for Teachers (NETS-T) among middle school teachers.

Teacher Professional Development and Preparation for Unfamiliar Roles

One factor that can hinder teacher buy-in to 1:1 computing is lack of teacher comfort with technology. Two schools that reported this problem also reported teacher's comfort had improved over time, possibly attributable to professional development and experience:

> *A lot of our teachers who were first afraid of the technology, they feel more comfortable with it now than they did a year [or a] year and a half ago. I'm not saying they're using it 24/7, but they feel as if they can go on there and find a Web site if they need to, use a program if they need to, ask for help when necessary.*

Another factor that can hinder teacher buy-in to 1:1 computing is lack of comfort with classroom management. Participants noted anxious teachers held three fears: fear of responsibility for expensive laptop equipment with the potential for student abuse; fear of not having enough technology skills to lead a classroom full of laptops; and, fear of maintaining discipline when managing a more open and collaborative, laptop-based learning environment. Despite these fears, focus group participants noted teachers again became more comfortable with their laptop programs over time, learning to trust students with technology more and deal with any damages that occurred, learning to trust their own skills more and seek help from peers and students when needed, and learning to work outside of their comfort zones by releasing some control to students with decreasing emphasis on disciplinary problems that could occur:

> *For some, they're just so used to having that control and that quiet classroom that they think has to exist in order for it to be successful. ... So they're afraid they're going to lose that control. But I think the more ... that they understand how children learn and are involved in activities ... teachers are more apt to be comfortable in allowing that to occur.*

As noted across all focus groups, schools did not assume teachers would adjust to the 1:1 computing environment as in the examples above, but proactively provided for multiple sources of teacher professional development and preparation to encourage buy-in. Teachers were commonly taught how to work with networks and infrastructures, how to use course

management systems and Web-based tools, and strategies for managing student laptops in their classrooms such as turning student desks away from the teacher so he/she could readily see student screens for monitoring.

Sources of professional development varied in addition to the topics. Three tf/mc pairs indicated their schools had purchased books and periodicals for teachers to learn about new tools such as Moodle. Two tf/mc pairs noted teachers were using online tutorials and webinars. Some schools were using online courses offered by the Friday Institute on the topic of "managing the 1:1 classroom," and appreciated not only the content but also the ability to study in a Moodle environment and learn what a course management system can do.

The structure of professional development varied by school. In nearly every focus group, participants indicated their teachers received formal face-to-face professional development. The length and depth of formal training events varied widely and included: professional development during teacher planning periods (every two-six weeks), weekend/Saturday sessions, week-long technology institutes at individual schools during the summer, and multi-day events with combined 1:1 schools at the Friday Institute. A variety of persons led formal professional development from external consultants, to staff from more experienced 1:1 schools, to technology facilitators and media coordinators, to teachers themselves:

> *How Cool is This has been wonderful. And it's just a great idea for teachers to have that experience of being a real teacher leader. Standing in front of their colleagues and saying, "This is what I'm doing. This is how I'm making this work."*

In every focus group except the technology director focus group, participants also mentioned that teachers learned to integrate technology via informal planning sessions with school technology facilitators or media coordinators. In many cases, planning sessions were described as "professional learning communities," where all of the teachers in a given content area (e.g., math, English), would co-plan units together during a common planning period, sometimes with the aid of a technology facilitator or media coordinator:

> *Each of my teachers gets four impact days where they work one on one or at most two on one with my tech facilitator. And he'll sit down and say, "What do you want to do? What's your goal for this unit? What type of assessment do you want to put in place?" And they'll work one on one on planning that.*

In both principal focus groups and in two tf/mc focus groups, participants discussed the idea of training more advanced teachers as "models" or "trainers" to assist less advanced teachers. Model teachers were used in these schools to lead both formal professional development and informal planning sessions. One middle school principal noted they had instituted "peer classroom visits" where other teachers' classrooms served as models. Considerable evidence suggests teachers learned to use technology through casual sharing on a daily basis:

> *It really has become a collaborative atmosphere of teachers sharing with each other. It even happens outside. It happens in the morning. It happens at lunch. It happens after school.*

Teacher Collaboration

Multiple forms of teacher collaboration were noted in focus groups, including formally scheduled discussions, informal discussions, online discussion in communities, and cross-discipline discussion. The most common form of teacher collaboration discussed was formal sharing in teacher teams with teachers meeting on a regularly scheduled basis to share their technology ideas with peers:

> *..the math department is finally working much more as a team, and I'll be honest... this is my 4th year, and that's a big change from when I first came.*

The second most common form of collaboration reported by four schools was informal sharing of ideas across peer teachers:

> *I hear conversation, teachers talking about, "Well, have you used Quia, how can I do this in Quia, how are you using it," and they're talking to each other, and they're sharing ideas with each other. I've picked up a lot of lessons just by listening to other people in other departments talking.*

While less prevalent overall, one other form of collaboration noted was teacher online communities for sharing ideas with other educators outside of their district. This may be particularly useful in smaller high schools where there is only one teacher in a given subject area (e.g., foreign language).

In the high school principal focus group, participants noted that as peers share more, there is less need to

schedule formal professional development. In one case, a teacher reportedly created a wiki for peers to post questions, or as a principal noted, teachers email new resources and tools to each other. High school principals noted teachers had become more collaborative in 1:1 environments, including some cross-discipline collaboration:

> *I can say the culture here has really changed.... At first it was ... English doesn't mess with Math, Math doesn't mess with Science. But now they're sharing across the disciplines and it's, "We're all in this together." ... And they're realizing, "Hey, I do share my students with the Science teacher, with the Math teacher." ...we need to collaborate and make sure we're speaking the same language and introducing materials the same way. So I've really seen the culture change over the last two years here at the high school.*

Flexibility to Adapt Instructional Practice over Time

Two schools suggested teachers would be more likely to buy-into a 1:1 project if the school administration allowed teachers to drive changes rather than mandating usage of specific tools and strategies. Four tf/mc pairs and the high school principals emphasized the importance of school leaders not pressuring teachers to integrate technology where it doesn't fit or to change at an uncomfortable pace. Teachers want to remain in control of their classroom environment from the bottom-up, and use technology when it fits as one of many tools in their teaching arsenal:

> *As an administrative team, do not go in there and tell all of your staff that they will learn all of these programs and that they will fully implement all of these programs.... Pick one that works for your subject area and become an expert in it and run with it.*

Focus group participants noted it is important to identify teachers with greater needs and provide differentiated instructional or technical support. For example, one middle school principal described a program called "tech buddies" where late adopting teachers were paired with early adopting "tech buddies" who could assist them with issues, so they didn't have to wait on an appointment from a tf/mc or district-provided tech support:

> *The Smart Monday idea that we had worked really well for some of those people, because they can come for one-on-one [help] and they wouldn't have to reveal themselves but to that one person, and they would get [the support] they needed.*

In four tf/mc focus groups, the technology director focus group, and both principal focus groups, participants repeatedly noted teachers change at different speeds, but everyone can pick a few things to focus on and will gradually build their repertoire with technology. The differentiated levels of adoption were described using metaphors of "speedboats" for the early adopters and "tugboats" for the reluctant adopters:

> *If some of the teachers who are more technologically afraid do one thing this six weeks, and add one thing the next six, then they'll be successful at what they're doing. The kids are going to have interaction with 1:1.*

Despite giving teachers time and flexibility to make changes, principals also cited "non-negotiables" or core expectations they set for all teachers to follow. One middle school principal noted an expectation that all teachers would indicate how technology was integrated in their lesson plans, and one high school principal noted all teachers would post their lessons and assignments on a course management system. Non-negotiables are generally recommended to set a bar, but as one high school principal noted, over time they may be removable, once teachers begin to use technology without being asked to.

In the middle school principal and one tf/mc focus group, participants noted principals don't always have to pressure teachers to integrate technology, since a lot of indirect pressure comes from advanced peers who are showcasing new teaching strategies in their classrooms:

> *Our principal I think has done a really good job not to force the hand of the teachers and not really say you must do this, this, and this. I think that those teachers that have been running with the technology and really incorporating this, and really changing the teaching and learning, they're kind of indirectly putting pressure on their peers which makes the others feel like I need to do this.*

Likewise, high school principals also discussed how internal pressure to change and adopt technology comes from students as well:

> *Pressure from students... "How come we're not using this in this class? We bring it every day." "When are my grades updated?" "I just did an assignment. It's not in there. Have you graded it? Why isn't it in there?"*

Dependability of Networks

One factor that negatively impacted buy-in at two schools was the unpredictability associated with technology resources and internet access. Teachers reportedly felt some reluctance to integrate technology into their lessons when they could not depend on the technology. Study participants reported teachers were not happy spending extra time creating two versions of their lesson plans--one with and one without technology, and further teachers did not like spending class time troubleshooting unexpected technology problems:

> *We lost a lot in terms of teacher buy-in when the network went down for five days…two days before school began and another three days into school…For some of the teachers, technology is hard, and they finally bought in and were trying and [then the network went down]…I think we lost a couple teachers because they can't rely on it; when they really needed it, it wasn't there.*

Discussion

Background literature suggests 1:1 leaders must tend to multiple roles, including: learner, motivator/change agent, technician, instructional leader, purveyor of resources, and evaluator. Study findings largely corroborated the need for such roles and helped to clarify each role with specific competencies or requirements.

In the roles of learner and instructional leader, for example, study participants suggested leaders need an enhanced understanding of software, digital resources, and tools, which are capable of improving student learning, as well as an understanding of the educational affordances of supplemental hardware equipment. Leaders may also benefit from an understanding of technology models that can serve as foundations or guidance for an initiative. With such knowledge, leaders will be better positioned to provide meaningful professional development for instructional staff.

In the role of motivator/change agent, study findings suggest leaders should establish planning teams and involve stakeholders in project planning, provide for teacher professional development and understanding of foundational models, encourage teacher collaboration and sharing, and provide teachers with some flexibility to adapt practice over time. Tending to the role of technician and developing a sound technical infrastructure was also suggested to be related to teacher motivation/buy-in.

In the role of technician, study participants suggested leaders should have an understanding of and/or employ adequate human resources to manage such items as: hardware security, networking hardware, file storage, Web site filtering, purchased software or site subscriptions, and supplemental equipment.

In the role of purveyor of resources, study findings suggest leaders will need to purvey such resources as: space for siting laptops prior to and after deployment; human resources for technical support and infrastructure development; software solutions for instruction, security, file storage, and filtering; hardware solutions for instruction and networking; and financial resources for sustaining all of the above.

Perhaps the only role not specifically mentioned by study participants was that of evaluator, although leaders acknowledged the need to establish planning teams which would be used to set programmatic goals useful in tracking program progress. Further, participants placed considerable value on technology models for grounding appropriate instructional practices, and it would be possible to establish indicators and benchmarks of success based on the recommendations in such models.

Conclusion

A variety of administrative personnel are involved in implementing technology initiatives in schools, including principals, technology facilitators, media coordinators, and technicians. This paper provides a practical list of considerations for those involved in administering 1:1 computing initiatives in particular, in support of program planning and leadership, infrastructure planning, and promoting teacher motivation and buy-in. The lessons learned from 1:1 program administrators should prove helpful to other schools and districts who are considering the adoption of ubiquitous computing environments.

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REFERENCES

[1] Anderson, Christine. "A Delphi study of the strategies that will help superintendents overcome the barriers to

the implementation of one-to-one laptop programs in K-12 schools by 2011" (Doctoral dissertation). Retrieved from *Dissertations & Theses: A & I*, 2008.

[2] Bebell, Damian, and Rachel Kay. "One to one computing: A summary of the quantitative results from the Berkshire Wireless Learning Initiative." *The Journal of Technology, Learning, and Assessment, 9*(2), 2010.

[3] Chang, I-Hua, Joseph Chin, and Cheng-Mei Hsu. "Teachers' perceptions of the dimensions and implementation of technology leadership of principals in Taiwanese elementary schools." *Educational Technology & Society, 11*(4), 229-245, 2008.

[4] Charmaz, Kathy. "Constructionism and the grounded theory method." In J.A. Holstein & J.F. Gubrium (Eds.), *Handbook of Constructionist Research* (pp. 397–412). New York: The Guilford Press, 2008.

[5] Cutter, Chris. "One-to-one wisdom: Expert tips on how to approach professional development in laptop environments." *Technology & Learning, 26*(9), 30, 2006.

[6] Drayton, Brian, Joni Falk, Rena Stroud, Kathryn Hobbs, and James Hammerman. "After installation: Ubiquitous computing and high school science in three experienced, high-technology schools." *The Journal of Technology, Learning, and Assessment, 9*(3), 2010.

[7] Ertmer, Peggy, Hua Bai, Chaoyan Dong, Mohammed Khalil, Sung Hee Park, and Ling Wang. "Online professional development: Building administrators' capacity for technology leadership." Retrieved from ERIC database, 2002.

[8] Flanagan, Linda, and Michele Jacobsen. "Technology leadership for the twenty-first century principal." *Journal of Educational Administration, 41*(2), 124-142, 2003.

[9] Fletcher, Geoffrey H. "A matter of principals." *T.H.E. Journal, 36*(5), 22-28, 2009.

[10] Friday Institute. "Evaluation of Educational Innovations." Retrieved from https:// www.fi.ncsu.edu/what-we-do/evaluation/, 2012.

[11] Maninger, Robert M. and Mary Elizabeth Holden. "Put the textbooks away: Preparation and support for a middle school one-to-one laptop initiative." *American Secondary Education, 38*(1), 5-33, 2009.

[12] O'Dwyer, Laura, Michael Russell, and Damian J. Bebell. "Identifying teaching, school and district characteristics associated with elementary teachers' use of technology: A multilevel perspective." *Education Policy Analysis Archives, 12*(48), 2004.

[13] Penuel, William R. "Implementation and effects of one-to-one computing initiatives: A research synthesis." *Journal of Research on Technology in Education, 38*(3), 329-348, 2006.

[14] Sclater, Jennifer, Fiore Sicoly, Philip C. Abrami, and C. Anne Wade. "Ubiquitous technology integration in Canadian public schools: Year one study." *Canadian Journal of Learning and Technology, 32*(1), 2006.

[15] Shapley, Kelly S., Daniel Sheehan, Catherine Maloney, and Fanny Caranikas-Walker. "Evaluating the implementation fidelity of technology immersion and its relationship with student achievement." *The Journal of Technology, Learning, and Assessment, 9*(4), 2010.

[16] Warschauer, Mark. "Going one-to-one." *Educational Leadership, 63*(4), 34-38, 2005/2006.

[17] Weston, Mark E., and Alan Bain. "The end of techno-critique: The naked truth about 1:1 laptop initiatives and educational change." *The Journal of Technology, Learning, and Assessment, 9*(4), 2010.

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