

LITERATURE REVIEW
ONE-TO-ONE AND BRING YOUR OWN DEVICE
TECHNOLOGY PROGRAMS: SCHOOL DISTRICT
EXPERIENCES AND SUMMARY OF BEST PRACTICES

Christie Blazer, Supervisor

Research Services
Office of Assessment, Research, and Data Analysis
Miami-Dade County Public Schools
1450 N.E. Second Avenue, Suite 208
Miami, Florida 33132

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LITERATURE REVIEW

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At a Glance

Miami-Dade County Public Schools (M-DCPS) briefly delayed its technology initiative late last year in order to carefully study what went wrong with some of the technology programs being implemented in other school districts around the country. M-DCPS' technology initiative is now back on schedule, with plans to distribute 100,000 laptops and tablets to students by no later than August 2015. The district is installing wireless systems and improving bandwidth at all of its schools and already allows students to bring their own computing devices to school. Across the country, some districts have encountered difficulties with the implementation of their technology programs, while others have had highly successful rollouts. This Literature Review summarizes these districts' experiences and the recommendations they have provided for other districts that are preparing to launch their own technology programs. Following these district summaries, this report reviews best practices for school districts to follow when implementing technology initiatives. In addition, issues that districts must resolve prior to launching their technology programs are summarized.

In October 2013, Miami-Dade County Public Schools (M-DCPS) “pushed the pause button” on its digital technology initiative, citing difficulties encountered with the rollouts of similar programs in other U.S. school districts. M-DCPS delayed the distribution of technology devices so the district could carefully study what went wrong with some of the other programs around the country. In January 2014, M-DCPS announced that it was ready to launch its technology initiative (Smiley, 2014).

Between February and April 2014, approximately 13,000 laptops will be deployed to elementary students and about 15,000 tablets will be deployed to seventh grade civics students and high school freshmen taking world history. In August 2014, all world history students will be given tablets and iPrep math students who lack technology at home will be given laptops. M-DCPS plans to distribute a total of 100,000 laptops and tablets by August 2015, if not sooner (Smiley, 2014).

M-DCPS is spending \$100 million through its November 2012 bond initiative to install wireless systems, improve bandwidth, and purchase additional classroom technology for all of its schools. M-DCPS already allows students to bring their own devices to school at all of the district's campuses, in order to ensure that every student has access to a laptop or tablet and digital content (Smiley, 2014; Herold, 2013a; M-DCPS, 2013; Smiley, 2013).

Before laptops and tablets are deployed in fall 2014, M-DCPS will study the effectiveness of the first wave of its technology program and identify any challenges associated with the initiative. The district will also evaluate the success of its small take-home program (1,000 devices this

spring and perhaps 1,500 in the fall) and the air cards that will be given to students to ensure they can access the Internet at home (Smiley, 2014).

For more information on M-DCPS' BYOD program and Wi-Fi access, the reader is directed to the district's *BYOD – Wi-Fi Access* Webpage (<http://wifi.dadeschools.net>).

This Literature Review provides a summary of several school districts' experiences with the implementation of their one-to-one and Bring Your Own Device (BYOD) technology programs. Some districts, such as the Los Angeles Unified School District and Guilford County Schools in North Carolina, have encountered serious difficulties with their technology rollouts. Other districts have had what are considered to be highly successful rollouts, including Mooresville Graded School District in North Carolina and Oak Hills Local School District in Ohio. Following these district summaries, this report reviews best practices for school districts to follow when implementing technology initiatives, based on the experiences of districts around the country. In addition, issues that districts must resolve prior to launching their technology programs are reviewed.

DISTRICTS THAT ENCOUNTERED DIFFICULTIES WITH THEIR TECHNOLOGY PROGRAMS

The following school districts experienced difficulties when they rolled out their technology initiatives:

Los Angeles Unified School District

At the beginning of the 2013-2014 school year, the Los Angeles Unified School District (LAUSD) began Phase 1 of its Common Core Technology Project, as its iPad initiative is formally known, distributing 31,000 iPads to students at 47 schools. LAUSD originally intended to distribute iPads to students at the district's remaining 786 K-12 schools during the 2014-2015 school year. However, after the district encountered a number of difficulties with program implementation last fall, LAUSD officials decided to delay the district-wide rollout of iPads.

In January 2014, the LAUSD School Board unanimously approved Phase 2 of the iPad plan. This next phase will provide iPads to students at 38 new schools, provide high school students at seven schools with laptops, acquire keyboards for Phase 1 and 2 schools, and equip all schools with enough iPads for all students to take the new state tests in the spring. The Board's decision went against the advice of the Bond Oversight Committee, which recommended that the board limit the number of devices purchased during the 2013-2014 school year (Blume, 2014; Romo, 2014; Smith, 2014; Cavanagh, 2013; Herold, 2013b).

LAUSD experienced the following difficulties with Phase 1 of its iPad initiative:

- The Pearson instructional software installed on LAUSD iPads is incomplete. It currently consists of a few sample lessons in mathematics and English/language arts per grade level. Eventually, the software is expected to include between 145 and 150 lessons per subject and grade, assessments, supplemental materials for students with different skill

levels, and built-in tools for taking notes and annotating texts. In the meantime, there have been reports that teachers are struggling with how to use the iPads for classroom instruction, given the extremely limited scope of the digital curriculum available (Herold, 2013b).

- Many experts believe that the district rolled out the program too quickly (Herold, 2013b; K-12 News Network, 2013; Kamenetz, 2013). Leslie Wilson, chief executive officer of the One-to-One Institute, a nonprofit organization that provides support to districts implementing one-to-one technology programs, said, “What we don’t do is deploy thousands of devices into a system that is not prepared from a human capital, network, bandwidth, or security standpoint” (Herold, 2013c).
- Some observers claim that LAUSD’s lack of a clear financial plan hindered their efforts. For example:
 - Critics claim that LAUSD paid too much for its iPads. Most estimates put the total cost of each iPad, pre-loaded with Pearson software, at \$768 per iPad (Blume, 2014; Smith, 2014; Molnar, 2013).
 - District officials said they did not know how much they paid Pearson for the instructional software installed on the iPads because Pearson is a subcontractor for Apple. Pearson officials referred questions to Apple, and Apple declined to comment (Herold, 2013b).
 - The district will lose its right to use the English/language arts and mathematics curriculum installed on district iPads in July 2016. Buying a new license for the curriculum will then cost the district \$50 to \$100 each year per iPad, an additional expense that could surpass \$60 million annually. Under the district’s delayed distribution schedule, most students will receive iPads in fall 2015, shortly before the license expires (Blume & Ceasar, 2013; Herold, 2013b).
 - The district announced in September 2013 that it will spend an additional \$38 million on wireless keyboard accessories so that students will be able to take assessments on their iPads. Critics point out that LAUSD should have anticipated keyboard needs prior to finalizing the purchase of iPads (Kamenetz, 2013; Romo, 2013).
- LAUSD struggled to develop rules and protocols to guide the use of the iPads. For example, there was confusion about whether parents were liable for the iPads if they were lost, stolen, or broken (Banks, 2013; Blume, 2013a; Herold, 2013b; K-12 News Network, 2013). LAUSD required parents to sign a form acknowledging that they were financially responsible if their child broke or lost the device, but according to the *Los Angeles Times*, it is unclear if the forms were signed prior to giving iPads to the students or whether the forms were legally binding (Newcombe, 2013a).

- Teachers were not fully trained to use the tablets (Banks, 2013). Kamenetz (2013) spoke with two LAUSD contractors who claimed to have first-hand knowledge of the iPad rollout. The contractors confirmed that lack of teacher training was a major issue, stating, “Teachers were not trained in the system to manage the devices. Nobody at the school was trained.”
- Over 300 LAUSD students deleted security filters on their district-issued iPads in order to access Facebook, Twitter, Pandora, and other unapproved Websites when using the devices outside of school. In addition, over 70 iPads disappeared during the 13-school pilot program in spring 2013 (Blume, 2013a; Herold, 2013c; Westervelt, 2013).

LAUSD is taking steps to ensure the future success of their one-to-one technology program. For example:

- The LAUSD School Board decided that a slower pace will lead to a more effective program, both logistically and academically. Under the program’s original timeline, tablets would have been distributed to all LAUSD students by December 2014. The deadline has been pushed back to the fall of 2015. The School Board also requested that an evaluation be conducted to determine whether or not the project should proceed. This evaluation could result in further delays in the district-wide rollout (Blume, 2013b; Molnar, 2013; Romo, 2013).
- The LAUSD issued a statement detailing the actions it has taken to “ensure it has 100 percent control over what is accessible” on the devices. These actions include:
 - Students will no longer be permitted to take tablets off school grounds. At the three high schools where students deleted security filters, LAUSD staff ordered that all tablets be returned (Banks, 2013; Blume, 2013a; Brustein, 2013; Herold, 2013c; Leonard, 2013).
 - The district will enhance its ability to remotely control tablet content. Apple’s new operating system will include functionality that will allow the district to lock down the devices and prevent student tampering (Herold, 2013c).
 - Students, educators, and parents and guardians will be held accountable for responsible technology use. LAUSD is emphasizing a cybersecurity awareness program, incorporating digital citizenship lessons into its curriculum, updating its discipline policies, and redoubling its efforts to get acknowledgement forms signed by parents (Herold, 2013c).
- The LAUSD School Board voted to launch a pilot test of laptops among high school students to evaluate whether they suit older students better than iPads. Laptops, instead of iPads, will be provided at seven of the district’s high schools. Further technology plans will depend on the outcome of the study (Blume, 2013b; Romo, 2013).

Fort Bend Independent School District (Texas)

In Texas, the 70,000-student Fort Bend Independent School District (FBISD) discontinued its iPad initiative in early October 2013. The program, iAchieve, originally launched in February 2012 and combined the purchase of new iPads and wireless network upgrades with a new set of science lessons and simulated experiments for students in grades 4, 5, and 8. FBISD spent \$16 million in bond, grant, E-rate, and general operating funds. Over 6,000 iPads were delivered to 14 schools and equipment was installed to enhance wireless connectivity at 34 schools. After 19 months of problems, the program was finally cancelled: wireless coverage was spotty; digital lessons did not match district standards; and interactive tools never got built (Herold, 2013d; Leonard, 2013; Michels, 2013; Smiley, 2013).

Concerns about the program's implementation and costs were raised by School Board members and FBISD's new superintendent, leading the district to request a formal review of the iAchieve program. Key findings of the program review, conducted by the Gibson Consulting Group (2013), included:

- FBISD established an overly aggressive timeline for the design, testing, and implementation of iAchieve.
- The iAchieve program was hindered by not having a qualified, fully dedicated staff member with expertise in large-scale project management, curriculum development, and instructional technology to coordinate the various teams and contractors involved in the program.
- FBISD employed poor contract management practices. Project deliverables and payments did not match the contract requirements, and highly unrealistic timetables were negotiated and agreed to by both parties.
- The science curriculum was not consistent with FBISD standards. The methodology used when writing the science curricula, which emphasized specific scripts for teachers and did not follow the district's lesson-building standards, resulted in content that teachers and curriculum leaders felt was unusable without substantial changes.

Guilford County Schools (North Carolina)

In the 72,500-student Guilford County Schools, officials announced in October 2013 that they have suspended the use of tablets and related equipment provided by digital device supplier Amplify. The technology initiative was funded through \$30 million in federal Race to the Top - District funds and \$5 million in supplemental grants. In May 2013, Amplify won an estimated \$14 million contract to supply 17,000 students in 18 Guilford County middle schools with its devices (Ferenstein, 2013; Herold, 2013d; Leonard, 2013; Smiley, 2013).

After only two months, 10% of the district's 15,000 devices had been returned to Amplify with broken screens. Schools also reported problems with approximately 2,000 Amplify-supplied cases. A student charger overheated, causing its plastic casing to melt. Guilford County Schools suspended the use of all Amplify tablets, cases, and keyboards as a safety precaution. All tablets were recovered and secured by district officials (Guilford County Schools, 2013; Spencer, 2013).

Baldwin Unified School District (Kansas)

In February 2013, the Baldwin Unified School District (BUSD) School board approved a three-year lease-purchase agreement that provided the district's high school with 475 iPads at a cost to the district of over \$90,000 per year. Families are required to pay a \$50 fee if they want their children to take their iPads home at night. No fee is charged if students leave their iPads at school in the evening (Baldwin City Signal, 2013; Jones, 2013a; Jones, 2013b).

When BUSD's technology initiative began in the fall of 2013, the program encountered numerous difficulties that frustrated students, faculty, and administrators, such as:

- Wi-Fi connectivity problems prevented teachers and students from using the iPads as planned. Problems included iPads not communicating correctly with the Wi-Fi system and Wi-Fi access points rebooting when a certain number of iPads accessed them. Although the district doubled its Wi-Fi capacity in the high school last spring to accommodate the greater demand caused by the iPads, it did not anticipate the difficulties that would occur when 400 students moved from room to room and from one access point to another.
- The school's fiber network went down.
- My Big Campus, the Web-based social media platform used by the school, experienced inconsistent connectivity (Baldwin City Signal, 2013; Jones, 2013a).

The district corrected most of the difficulties:

- Additional Wi-Fi access points were added throughout the high school.
- Engineers with the firm that manufactures the school's wireless access points and the company that installed them determined that updated software downloaded before the start of the 2013-2014 school year was faulty. The older software, which worked fine, was re-installed.
- The crash of the school's fiber network was traced to squirrels chewing through a central line. The line was repaired.
- Staff from My Big Campus are working with the school to search for solutions to their platform's lack of consistent connectivity (Baldwin City Signal, 2013; Jones, 2013a).

Clark County School District (Nevada)

The Clark County School District in Nevada uses a hybrid approach for its technology program. The school district developed a BYOD policy and installed Wi-Fi networks at all of its schools. The district also began implementation of a one-to-one initiative and provided devices for low-income students in order to address equity and access challenges. Clark County's BYOD program was implemented in 2013-2014 and allows the district's 311,000 students to use their own devices at school. In 2012-2013, Clark County launched an iPad initiative that distributed over 7,000 iPads to students and staff at five low-income middle schools. The district plans to further expand the iPad initiative (Boulton, 2013; Takahashi, 2013a).

Since the start of the iPad program, police have seen a spike in the number of iPad thefts, with thieves targeting school children carrying district-issued iPads to and from school. Eighty-three iPads were stolen from students during the 2012-2013 school year. The school district has attempted to address this problem by taking the following actions:

- Students have been taught to keep their iPads hidden while walking to and from school.
- Each iPad has a serial number and “Find My iPad” recovery app installed. The serial number is used by local pawn shops to identify stolen district property, and the recovery app uses GPS and Wi-Fi signals to pinpoint the location of missing iPads. The school district’s police department uses the coordinates to dispatch officers to the iPad’s location (Crowther, 2013; Takahashi, 2013b).

New York City Public Schools

In April 2013, the New York City Department of Education began paying back wages to more than 30,000 special education teachers, school psychologists, social workers, and others after an arbitrator agreed with the United Federation of Teachers that many of its members had been improperly forced to work beyond their contractually mandated workday to implement a new online system that tracks and services special education students. The problems began during the 2009-2010 school year, when New York City’s public schools began implementing a new software program called SESIS (Special Education Student Information System). Problems included:

- The SESIS program was described as “rigid” and unreliable, regularly failing to process key information and documents.
- Due to insufficient school bandwidth and slow Internet connections, thousands of educators were required to log on to the system after hours at home.
- Teachers were not provided with adequate training or technical assistance for the new program.

As of October 2013, the New York City Department of Education had paid \$41 million to over 30,000 educators to reimburse them at their hourly rate for time spent using the SESIS system outside of their contractually mandated workday. According to Doug Levin, Executive Director of the State Educational Technology Directors Association, “This is the first time I am aware of a public school system being held accountable, in a legal manner and with real dollars attached, for the quality of its broadband infrastructure, software implementation, and training” (Herold, 2013e).

The SESIS system is still in place in New York City’s public schools and the Department of Education reminds principals that staff members should not use the system once the school day ends unless the principal has committed to pay for that time. The Department of Education has not provided principals with additional money to pay teachers for SESIS work and maintains that the system does not require work outside of the school day. According to Chalkbeat New York, a non-profit news organization covering educational efforts, most principals appear to be following these new guidelines. However, some teachers report that they still work on the SESIS system at home, at night, because they don’t have time to create and update Individual

Education Plans or document their encounters with students with disabilities during the day. The system received several upgrades in October 2013 designed to make the interface more user-friendly, but some teachers claim that the changes were mostly cosmetic (Darville, 2013).

DISTRICTS THAT HAVE IMPLEMENTED SUCCESSFUL TECHNOLOGY PROGRAMS

The following school districts successfully introduced technology programs and have offered recommendations, based on their implementation experiences, to other districts that are considering implementation of similar initiatives.

Oak Hills Local School District (Ohio)

Oak Hills Local School District in Cincinnati, Ohio implemented a BYOD program at its high school in the fall of 2010. Students at the district's elementary and middle schools are finishing a BYOD pilot before the program is offered to all students. Based on their successful rollout of the BYOD program, Oak Hills has provided a framework for other school districts to use when they implement their own BYOD program. The nine recommended implementation and support steps are as follows:

1. Engage the community to acquire the support and buy-in of all parties involved, including parents, students, staff, administrators, school board members, and business leaders.
2. Develop a core team of teachers and technology staff to work with students, parents, and administrators on a regular basis to explore new technologies, plan professional development, and address overall planning and troubleshooting.
3. Develop a properly planned and designed wireless and security infrastructure.
4. Develop software tools that can be used with multiple types of devices.
5. Develop a portal or a central location that collects information on Web-based software applications.
6. Develop an Acceptable Use Policy (AUP) that specifies where and when devices can be used, as well as policies for social networking and messaging. AUPs should outline appropriate behavior in positive terms, outline inappropriate behaviors, and describe the procedures involved with following or not following the AUP.
7. Build a curriculum that encourages the use of technology.
8. Consider the types of devices students will be permitted to bring to school. The ideal computing device for school use is lightweight and sturdy; is in a protective carrying case; has several hours of battery power and easy options for recharging; has wireless capabilities and appropriate software; and has USB ports and other options for expansion.
9. Monitor usage of network resources, course and content pages, and apps in order to develop a better understanding of how students use their technology (Oak Hills Local School District, 2012).

Forsyth County Schools (Georgia)

Forsyth County Schools initially piloted its BYOD program in 2010 with 40 teachers in seven schools. Now, BYOD is supported in every school within the 39,000-student district (Forsyth

County Schools, 2013; Lepi, 2012; Roscorla, 2011). Forsyth County Schools offered the following recommendations to districts that are considering a BYOD program:

- Survey students about which devices they own.
- Set up a task force to examine equity issues for students whose families cannot afford a digital device or Internet access.
- Get buy-in from parents and community members.
- Require students to agree to the district's Acceptable Use Policy.
- Require students to take responsibility for maintenance of their own devices.
- Prior to full program implementation, test connectivity by inviting students to bring in their devices.
- To avoid security problems, set up a separate BYOD network that acts as a security wall for student records and other sensitive information.
- Conduct multiple professional development sessions to improve teachers' ability to incorporate digital resources into the classroom (Flanigan, 2013; Scholastic, 2013; Lepi, 2012).

Forsyth County Schools learned that implementing a BYOD program required more than just changing technology policies. The district also made significant changes to its curriculum to accommodate the new technology and invested in teacher training and infrastructure. Lessons learned by Forsyth County Schools include:

- Increased technology in the classroom required that the district train and hire teachers who were willing to play the role of facilitator and allow students to direct their own learning. These teachers then showed other educators how to facilitate lessons using instructional technology in the classroom (Lepi, 2012; Roscorla, 2011).
- School administrators reported that it has been a challenge to get all teachers on board but they are working hard to help them learn new ways of interacting with their students (Lepi, 2012).
- The district had to triple its network capacity to handle the surge in demand and ensure that each school's network operated with the most up-to-date protocols so the newest devices connected properly (Newcombe, 2013b).
- Students who did not bring their own devices to school actually had more access to school-owned technology once BYOD policies were in place because there was less competition for digital devices that were owned by the school (Newcombe, 2013b).
- The district learned the value of partnering with local businesses to increase Internet access outside of school grounds (Flanigan, 2013).

Mooresville Graded School District (North Carolina)

Mooresville Graded School District (MGSD), located 20 miles north of Charlotte, started their digital conversion in 2007. Over 4,500 laptops have been distributed to every fourth through twelfth grade student and all licensed staff. Students and staff have access to the laptops 24 hours a day, seven days a week, for all 180 school days. Students take their laptops home daily to complete homework assignments and projects. According to *The New York Times*, MGSD has become the “de facto model of the digital school” (Farrell, 2013; Schwarz, 2012).

Veterans of the MGSD transition urge districts to consider the following 10 lessons before implementing their own digital initiatives:

1. Build enthusiasm among stakeholders in the schools and community. Before going digital, it is crucial to convince all stakeholders that they have a vested interest in the success of the conversion.
2. Form strategic alliances. To provide the resources needed for the digital conversion, Mooresville reached out to a wide variety of partners. For example:
 - Instructional technology experts from Apple and Discovery Education conducted professional development sessions that helped teachers and administrators implement curriculum changes.
 - To provide teachers with more intensive training, MGSD worked with a nearby university to offer three graduate degree tracks, including a master’s program in instructional technology.
 - MGSD worked with the local cable company to provide discounted packages to families that did not have Internet access at home.
 - By working with town officials, MGSD secured agreements for free Wi-Fi in parks, at the library, and in all municipal buildings.
3. Thoroughly think through logistics. Mooresville officials created a clear set of guidelines and operating procedures prior to the rollout of the program. For example:
 - Students are required to charge their laptops at night so the devices are powered up for class time.
 - Students must use a school-issued backpack with a laptop sleeve, in addition to another protective case, when they transport their laptop between home and school in order to minimize damage to devices.
 - Students and their families are required to take introductory classes at the beginning of each year to ensure that they understand how to operate and care for their laptops.
 - A robust firewall keeps students from accessing content that lacks educational value.
 - Families pay \$50 per year to subsidize computer repairs, though the fee is waived for those who cannot afford it (about 18% of families).

4. Rethink fund allocation. MGSD funds 98% of the digital conversion costs through its operating budget, reallocating existing resources to help support the technology initiative.
5. Ease teachers into the program. Mooresville teachers received new laptops to take home over the winter break in the first year, with encouragement to “just try them out.” The district then piloted the program with high school English teachers before distributing laptops to all of the district’s teachers. Mooresville officials believe that the steady pace of the transition “was pivotal in convincing teachers that the digital conversion wasn’t just the latest whim.”
6. Empower and educate teachers through the provision of meaningful and sustained professional development.
7. Watch the transformation, as students become more engaged in their learning and teachers embrace technology in their classrooms.
8. Collect and use data wisely. District officials believe that the ability to track students’ progress in real time has been a tremendous advantage for parents, teachers, and administrators.
9. Share experiences and best practices with educational colleagues around the country.
10. Continue to evolve. Mooresville teachers, curriculum experts, and technology staff are constantly vetting new interactive learning platforms and courseware. Dozens of vendors are regularly monitored to make sure the district receives the best prices and service (Farrell, 2013; Mooresville Graded School District, 2013).

REVIEW OF BEST PRACTICES FOR IMPLEMENTING BYOD AND ONE-TO-ONE TECHNOLOGY PROGRAMS

Just a few years ago, many school districts were developing one-to-one technology programs and providing each student with a laptop or tablet. As budgets have become more and more restrictive, however, most districts cannot afford a device for every student and have begun to embrace Bring Your Own Device (BYOD) programs. BYOD programs allow students to bring their personal computing devices to school, including laptops, netbooks, tablets, e-readers, cell phones, gaming devices, and MP3 players (Newcombe, 2013b; Takahashi, 2013a; Ackerman & Krupp, 2012; Dixon & Tierney, 2012; Ross, 2012).

Implementation of BYOD and one-to-one technology programs are substantial undertakings that require considerable planning, extensive communication, and ongoing analysis of expected educational and financial outcomes. Rollouts of technology initiatives in school districts around the country have led to consensus on many of the best practices for implementing BYOD and

one-to-one technology programs (K-12 News Network, 2013; One-to-One Institute, 2013). Best practices are summarized below.

Start small. Experts advise districts to start with a pilot program when implementing BYOD or one-to-one technology initiatives. Limited launches allow districts to study the successes and challenges of the programs and to obtain constructive feedback from participating schools (Livingston, 2013; Ackerman & Krupp, 2012; CDW-G, 2012; Fritschi & Wolf, 2012; Schacter, 2012).

Visit other school districts. Staff should visit other school districts that have implemented BYOD or one-to-one technology programs to collect information on best practices, prepare for challenges, and determine what will work within their own local school communities (K-12 News Network, 2013; Livingston, 2013; Saltpeter, 2013; Wainwright, 2013).

Engage stakeholders. The support of all stakeholders, including students, parents, teachers, administrators, and members of the community, is essential to ensure the sustainability of a technology initiative. School districts should obtain feedback from multiple stakeholders, be willing to listen to ideas and suggestions, and be prepared to answer questions honestly. Without open and direct communication, stakeholders are likely to be skeptical and emphasize cost rather than outcomes (Livingston, 2013; One-to-One Institute, 2013; Ackerman & Krupp, 2012; Colour My Learning, 2012; Dixon & Tierney, 2012). UNESCO's report, *Turning on Mobile Learning in North America*, emphasized the importance of characterizing the technology program as an "education initiative tied to clearly identifiable curricular goals" (Fritschi & Wolf, 2012).

Ensure equity. When implementing BYOD programs, it is important that all students have access to similar devices to guarantee equitable educational experiences. Districts must formulate a plan for students whose families cannot afford devices or opt out of the BYOD program. Some school districts offer stipends to help families purchase a device, some rent devices to students per semester, and others simply loan or give students their own devices (Boulton, 2013; Long, 2013; Wainwright, 2013; Ackerman & Krupp, 2012; Colour My Learning, 2012; Fritschi & Wolf, 2012).

Ensure that schools have sufficient bandwidth. One commonly reported problem among school districts implementing BYOD and one-to-one programs is insufficient bandwidth to support the substantial increase in student devices. The more devices attempting to access a network, the more access points and bandwidth required. In BYOD environments, students may bring two or three devices to school and simultaneously stream video or conduct other tasks that consume a lot of bandwidth. For these reasons, school districts with BYOD programs recommend planning for double the number of devices per user and assuming that all students will be online most of the time (Blackboard, 2013; Long, 2013; Project RED, 2013; Saltpeter, 2013; Wainwright, 2013; Alberta Education, 2012; Barseghian, 2012; Colour My Learning, 2012; Livingston, 2012; Robinson, 2012; Watters, 2012; Wilson & Gielniak, 2012).

One way to handle increased bandwidth demand is to limit the amount of bandwidth students can use. For example, the wireless network at Hoover High School in the North Canton City

(Ohio) Schools is throttled for video, gaming sites, streaming, and music. According to the district's technology director, "Throttling means that we put a limit to the amount of bandwidth that can be used for streaming video. We don't block them, but we throttle them" (Sungard K-12 Education, 2013).

Update Acceptable Use Policies. It is important for districts to have an updated Acceptable Use Policy (AUP) that is communicated to and signed by students every year. AUPs should outline policies for what, when, and how students can use their devices at school. Consequences for not adhering to policy, issues with cyberbullying, posting of inappropriate materials or comments, and other e-safety considerations should also be included (Saltpeper, 2013; Colour My Learning, 2012; Robinson, 2012; Schacter, 2012).

Protect data. BYOD brings with it a host of security issues, including data protection. Common concerns associated with the use of different devices on a network include access to administrative files and emails without proper authorization and threats to the network from an infected device. Districts should proactively use all available security measures in order to protect data, including email encryption, security patches, antivirus software, and monitoring services for hacking attempts (Bathon, 2013; Consortium for School Networking, 2013; Long, 2013; Schaffhauser, 2013; Alberta Education, 2012).

Potential solutions to data security threats include:

- Some experts recommend that school districts maintain multiple networks: one for Wi-Fi traffic, one for school district business, one for other secure information for teachers and administrators, and one for students and outside users of the district's Website (Ackerman & Krupp, 2012; Schacter, 2012).
- Most school districts require students and staff using personally owned devices to log into the network. The login process authenticates their credentials as a student or staff member. In some cases, devices are scanned daily, prior to connecting to the school's wireless network, in order to ensure they are free from viruses, spyware, or adware (Broward County Public Schools, 2013; Alberta Education, 2012).
- Colour My Learning (2012) suggested that school districts make antivirus and Internet security programs compulsory for all personal devices and offer this software to students at reduced rates.
- Some school districts, such as Fairfax County Public Schools in Virginia and the Osseo Area Schools in Minnesota are increasingly using "platform neutral" Web 2.0 applications such as Google Docs and Edmodo for teacher assignments and student work and collaboration. These applications not only work with any device that has a Web browser, but they also store work in the cloud, away from the district's servers (Alberta Education, 2012; Schacter, 2012).

- Districts must establish policies for the adoption of cloud services. Cloud service contracts should directly address the vendor's privacy obligations and include specific terms, such as the types of data that will be transferred or collected, the prohibition or limitation on disclosure of student data, the prohibition or limitation on the sale or marketing of student information without express parental consent, and the assurance that districts will have exclusive control over data access and mining (Reidenberg et al., 2013).

A study of a national sample of school districts conducted by Fordham Law School's Center on Law and Information Policy found that 95% of districts rely on cloud services for a wide range of functions and consequently transfer large quantities of student information to third party providers. The researchers concluded, however, that cloud services were "poorly understood, non-transparent, and weakly governed." They reported that an alarmingly high number of school districts relinquished control of student information when using cloud services, allowed vendors to retain student information in perpetuity, and did not have contracts or agreements setting clear limits on the disclosure, sale, and marketing of that data (Reidenberg et al., 2013).

Protect students from inappropriate content. Content filtering is a challenge for school districts that are implementing technology initiatives. The Children's Internet Protection Act (CIPA) laws require that all network access be filtered, regardless of the device used to access the network while in a public school. In order to comply with CIPA laws and protect students' safety online, school districts must use a secure and filtered Internet gateway to ensure that students have access to only appropriate resources on the Internet. A well-managed Web filter not only restricts students from accessing inappropriate content, but also allows schools to control the use of bandwidth and stop "bandwidth hogging" activities such as file sharing and large file downloads (Flanigan, 2013; Long, 2013; Ackerman & Krupp, 2012; Colour My Learning, 2012; Schacter, 2012). Unfortunately, no filtering system is foolproof. In the Los Angeles Unified School District, some students were able to hack through security filters (Herold, 2013c) and the Lewisville Independent School District in Texas suffered a security breach when Apple's iOS 7 update erased the district's firewall (Michels, 2013).

Teach students digital citizenship and responsibility. Researchers have concluded that technology programs are more successful when school staff help students understand the responsibilities that accompany online interaction. Digital citizenship courses should be conducted to increase students' awareness of cyberbullying; explain which types of digital communications are appropriate and which are not; develop students' sensitivity regarding the effect their online actions have on others; teach students to protect their online identity and manage passwords appropriately; and ensure that students understand that they must take precautions to protect electronic data, such as installing antivirus software and backing up documents (Ullman, 2013a; Ackerman & Krupp, 2012; Alberta Education, 2012; Dixon & Tierney, 2012).

Educate parents. In addition to posting information on the district's Website and distributing materials, districts should host informational meetings for parents prior to the implementation of

a new technology initiative. These meetings should explain the benefits of using technology in the classroom, the policies children will be expected to comply with, and how parents can monitor their children's online activities. District and school staff must anticipate parental concerns, which most commonly include online safety, Internet filtering, and children's safety when transporting devices between home and school (Saltpeter, 2013; Ullman, 2013a; Alberta Education, 2012; DeWitt, 2012; Dixon & Tierney, 2012; Livingston, 2012; Wilson & Gielniak, 2012).

Provide teachers with professional development. It is imperative that districts provide training for teachers in the incorporation of technology into instruction. Professional development should train teachers in the basics of technology, show them how to locate available Internet resources and support lessons across multiple platforms, as well as familiarize them with the district's Acceptable Use Policy. Collaboration among peers is also important so that educators have the opportunity to share examples of successful uses of technology, useful Web 2.0 tools, and effective classroom management strategies (Hanover Public School District, 2013; Livingston, 2013; Ullman, 2013b; Wainwright, 2013; Ackerman & Krupp, 2012; Colour My Learning, 2012; Dixon & Tierney, 2012; Levinson, 2012; Wilson & Gielniak, 2012).

Experts also recommend that professional development sessions begin prior to launching technology initiatives to give teachers time to learn and adapt to mobile technology before they use it in the classroom (Livingston, 2013; Saltpeter, 2013; Ullman, 2013a; Wainwright, 2013).

Continue to monitor the program and make adjustments when needed. Once technology programs are operational, districts must closely monitor program implementation and make continual adjustments to ensure that they run at peak efficiency (Ullman, 2013b; Colour My Learning, 2012). Schools should gather feedback from students, teachers, and parents throughout the year and make mid-course corrections if necessary. In addition, network capacity should be analyzed on a regular basis and equipment upgraded when needed (CDW-G, 2012; Levinson, 2012).

ISSUES DISTRICTS MUST RESOLVE PRIOR TO LAUNCHING TECHNOLOGY INITIATIVES

In addition to the above-mentioned best practices, there are many issues that districts must resolve before they launch technology initiatives. The following questions should be answered prior to implementing a BYOD program or providing students with their own computing devices:

How will the program be financed? Allocating funds for technology is no longer considered a luxury, but instead is an essential component of school districts' budgets. Many districts finance technology programs through a combination of local funds, federal grants, stimulus money, private donations, and the federal E-Rate program, which provides discounted telecommunications services to schools (Blackboard, 2013; Blazer, 2013; Ackerman & Krupp, 2012).

Even though BYOD programs are usually seen as cost-effective alternatives to providing each student with his or her own digital devices, they still require a substantial financial investment.

When implementing BYOD programs, school districts must still provide a secure network, bandwidth, wireless infrastructure, and mobile device management tools; teacher training on the integration of technology into instruction; and loaner devices for students who cannot afford to bring their own device (Dixon & Tierney, 2012; Wilson & Gielniak, 2012).

Some school districts have partnered with state or local agencies to lower their costs through volume discounts. For example, Charlotte-Mecklenburg Schools, the University of North Carolina at Charlotte, and the city's Central Piedmont Community College looked for opportunities to buy devices together in order to receive a discount from vendors. Similarly, schools in Minnesota joined with branches of the state government to obtain lower prices through a higher volume of transactions (Quillen, 2010).

When providing computing devices to students, some school districts ask for contributions from families. For example, parents in Mooresville Graded School District pay \$50 per year to subsidize computer repairs. Families in the School District of Waukesha (Wisconsin) pay a \$25 technology fee for students to take home their iPads. Similarly, families in Baldwin Unified School District in Kansas pay a \$50 fee if they want their children to take their iPads home. In two Wisconsin school districts with BYOD programs, families that cannot afford to purchase a device may rent a device from their child's high school (\$100 at the Denmark School District and \$75 at the Ashwaubenon School District). In addition to the financial benefits of such contributions, some experts believe that investing in a device gives students and their families a sense of ownership in the program (Alexander, 2013; Ferrell, 2013; Jones, 2013b; Millard, 2013a; Wilson & Gielniak, 2012).

Which computing devices will be permitted? School districts that are implementing BYOD programs should clearly explain to parents which devices will be allowed on the network and which devices, if any, will be excluded. Most districts allow students to bring any type of computing device to school, from cell phones to five-year-old laptops. District staff should also inform families of recommended specifications, operating systems, and software, including Internet security and antivirus protection (Wainwright, 2013; Colour My Learning, 2012; Livingston, 2012).

Whether implementing a BYOD program or supplying students with devices, experts agree that the ideal computing device for school use is lightweight and sturdy; has several hours of battery power and easy options for recharging; has wireless capabilities and appropriate software; offers sufficient storage; has multiple input methods (touch, type, and write); and is flexible with USB ports and other options for expansion (Saltpeter, 2013; Ullman, 2013a; Wlodarz, 2013; Intel, 2012; Oak Hills Local School District, 2012).

Will students be limited to a certain number of devices? District BYOD policies vary, with some districts limiting students to two or three devices and other districts imposing no limits on the number of devices they may bring to school (Alberta Education, 2012).

Will the district purchase or lease devices? There is no consensus among school districts that provide each of their students with a computing device on how to acquire the devices. Some districts choose to lease their devices, while other districts purchase them outright.

Leasing has several advantages for school districts. First, it is usually easier to include a regular lease payment in an annual budget than to plan for large purchasing expenditures every four to seven years. Second, leased devices are replaced much more frequently than purchased devices (usually every three or four years, instead of every six or seven years). Finally, leasing guarantees that school districts will not be saddled with obsolete equipment in the future (Ferrell, 2013; Vander Ark, 2012).

On the other hand, districts need to consider the leasing fees charged by most lenders. Assorted fees, specified only in the fine print, are often tied to the end of the lease, such as return fees, restocking fees, and damage fees (Stern, 2012). Vander Ark (2012) concluded that when school districts gradually phase in their technology programs (instead of rolling out programs at multiple schools simultaneously) and when they replace devices on an ongoing, planned cycle, it is cheaper to purchase devices than to lease them.

Will students be allowed to take devices home? Taking school-issued devices home has pedagogical justifications, for homework, extra practice time, and making stronger connections between home and school. However, there are practical objections to allowing students to take devices home, including potential targeting of students by thieves, greater potential for damage to devices, and the extra classroom time required to check out devices at the end of the day and check them back in first thing in the morning (Kamenetz, 2013).

Many districts implementing one-to-one programs allow students to bring their devices home with them (Baldwin City Signal, 2013; Farrell, 2013; K-12 News Network, 2013; Kelman, 2013a; Millard, 2013b; Saltpeter, 2013). However, increases in student muggings and disputes over who is responsible for damage, loss, and theft of devices has caused several school districts that originally allowed students to bring their devices home to revise their policies. For example, the Cleveland Heights – University Heights City School District in Ohio and the Los Angeles Unified School District now require students to leave their school-issued devices on campus when they go home. In the Cleveland Heights – University Heights school district, more than one dozen students were mugged on their way home from school less than one week after iPads were deployed. In Los Angeles, disputes arose over who was responsible for damaged, lost, and stolen devices (Banks, 2013; Kamenetz, 2013; Kelman, 2013b; Newcombe, 2013a).

What procedures will be followed when devices are forgotten at home? Most districts have loaner devices available for students who do not bring their device to school on a particular day (Dixon & Tierney, 2012).

When and where will students be permitted to use their personal devices? Most districts designate times and locations during the school day when the use of computing devices is prohibited (Anderson, 2013; Colour My Learning, 2012). At Marshall High School in Fairfax County Public Schools, for example, color-coded signs are posted throughout the building, indicating where use of personal devices is permitted or prohibited (Flanigan, 2013).

How will devices be stored when they are not in use? Whether districts implement a BYOD program or provide students with devices, there will always be times when students are not using their devices (i.e., during testing sessions, physical education classes, or extracurricular

sports). Consideration must be given to safe storage of devices when they are not in use. Many districts have invested in security carts – steel vaults that store devices when not in use and that can be rolled between classrooms (Kelman, 2013b; Alberta Education, 2012; Colour My Learning, 2012; Livingston, 2012).

According to a survey conducted by Absolute Software in 2012, public schools top the list of the most popular locations for thefts of mobile devices. Some schools lose hundreds of devices in a single break-in. At the DeSoto Parish School System in Louisiana, for example, more than 80 iPads were stolen from a high school library. At a K-8 center in California's San Jose Unified School District, thieves stole two security carts, one holding 30 laptops and one holding 30 iPads, from the computer lab. No devices were recovered (Kelman, 2013b; Schaffhauser, 2013).

How will the district keep track of school-issued devices? When providing students with computing devices, districts must decide which system they will use to maintain an inventory of devices, match devices with students, electronically check devices in and out of schools, identify damaged or lost devices, and automate app deployment (Raths, 2013; Rowe, 2013).

How will multiple types of devices be incorporated into classroom instruction? Managing the different platforms and devices that come into the classroom with BYOD programs is clearly more difficult and time-consuming than managing one type of device that is provided to all students by the district. Depending on platforms or even on different devices within a single platform, the same apps may not be available or their functionality may differ from one device to the next. Some districts purchase collaborative learning platforms or cloud apps that are compatible with any device students bring to the classroom and facilitate students' ability to communicate, publish, and share (Barseghian, 2012; Dixon & Tierney, 2012; Faas, 2012).

Which sites will the district's Internet filter block? District policies vary. Some districts allow social networking sites such as Facebook and Twitter, while other districts block students' access to these types of sites (Palmer Research, 2013; Dixon & Tierney, 2012). Gliksman (2012) recommended that districts set Web filter restrictions loosely to promote an expectation of personal responsibility, but take swift action when standards are not met.

Will students be allowed to bypass the district's network and use other networks (e.g., 3G or 4G) through plans supported on their devices? Districts that implement one-to one and BYOD technology programs do not permit students to bypass the district's network while on school grounds, as mandated by the Children's Internet Protection Act laws (Alberta Education, 2012; Quillen, 2011).

Will students be required to bring their devices to school fully charged? Most districts require students to bring their devices to school fully charged (Broward County Public Schools, 2013; Livingston, 2012).

Will students be able to print from their personally owned devices? Most districts do not allow students to print documents from their personal devices. Options provided include accessing a document from a school computer to print, or saving a document to a flash drive

and printing from home or another school computer (Broward County Public Schools, 2013; Hanover Public School District, 2013; Alberta Education, 2012; Allen Independent School District, 2011).

How will technical difficulties be handled? Most districts that implement BYOD programs do not allocate IT personnel to troubleshoot student-owned malfunctioning devices. Students who have technical issues with their devices are instructed to work with the user's manual that came with the device (Broward County Public Schools, 2013; Hanover Public School District, 2013; Robinson, 2012; Allen Independent School District, 2011). Faas (2012) pointed out that in reality, however, teachers usually end up as unofficial technology support. When students are instructed to use a device to look up a subject and one student is not able to use his or her device, the teacher is often the first person to try to resolve the issue.

Philadelphia Public Schools' Science Leadership Academy found an innovative way to handle malfunctioning devices. The school is a one-to-one laptop high school where computers are expected to last for four years (from freshman through senior year). In order to extend the life of their laptops, the school created its own in-house technology shop, where students learn to repair devices and provide software support for their laptops (Watters, 2012).

Who is responsible for broken, lost, and stolen devices? When implementing BYOD programs, school districts must clearly communicate to students and parents that the district and school are not responsible for damaged, lost, or stolen devices (Broward County Public Schools, 2013; Hanover Public School District, 2013; Robinson, 2012; Schacter, 2012; Allen Independent School District, 2011).

In districts that provide students with devices, replacement and repair costs mount quickly. Square Trade, an extended warranty service provider for consumer electronics, published a *2012 iPad Breakage Report*. The report found that 10% of all iPad 2 owners (who are not necessarily students) damage their devices within the first 12 months (Wlodarz, 2013). Marathon Venture Academy in Wausau, Wisconsin reported that 19% of the iPads distributed to students had to be sent out for repair during the school year. The majority of repairs involved the replacement of damaged screens at a cost of \$275 per unit (Wlodarz, 2013; Uhlig, 2012).

To help defray repair costs, the School District of Waukesha in Wisconsin requires families to pay a \$30 fee the first time a student damages an iPad. The fee doubles if the student damages the device again. A family's maximum repair cost is \$100. If the iPad is lost or stolen, families are responsible for replacing the device at a cost of \$500, unless certain conditions are met, such as the immediate reporting of the theft to school authorities and the police department. The district charges students a \$25 technology fee for the use of the district-issued iPads, but has paid for insurance on the iPads (Millard, 2013a; Millard, 2013b; Newcombe, 2013b).

School districts have tried to find ways to deter the theft of technology devices, both from school property and from students transporting devices between home and school. At Coachella Valley Unified Schools in California, iPads are equipped with a security system that can only be removed by Apple. The iPads shut down unless they "check in" with the school district network every time they connect to the Internet, rendering them useless if they are lost or stolen (Kim,

2013). At McAllen Independent School District in Texas, each iPad has been fitted with a tracking mechanism in case it is lost or stolen (Kelman, 2013a). At Clark County School District in Nevada, every iPad has a “Find My iPad” recovery app installed that uses GPS and Wi-Fi signals to pinpoint the location of missing devices (Takahashi, 2013b).

SUMMARY

Some districts, such as Los Angeles Unified School District and Guilford County Schools, have encountered difficulties with the implementation of their technology programs. Other districts, including Oak Hills Local School District in Ohio and Mooresville Graded School District in North Carolina, have had highly successful rollouts. This Literature Review summarized these districts’ experiences and the recommendations they have provided for other districts that are preparing to launch their own technology programs.

This report also summarized best practices for school districts to follow when implementing technology initiatives, based on the experiences of districts around the country. Best practices include engaging stakeholders, ensuring equitable educational experiences for all students, updating Acceptable Use Policies, protecting school district data, protecting students from inappropriate content, and providing teachers with training in the incorporation of technology into classroom instruction. In addition, issues that districts must resolve prior to rolling out their technology programs were reviewed. These issues include deciding how program funds will be allocated, determining whether there will be mandatory offline times and locations during the school day, setting policies for the printing of documents, determining how technical difficulties will be handled, and deciding who will be responsible for broken, lost, and stolen devices.

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