Minnesota Department of

Education

1:1 Device Programs Best Practices in K-12 Education

Fiscal Year 2016

Report

To the

Legislature

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Minnesota 2015 Special Session Law,

House File 1, Article 6, section 8

COMMISSIONER:

Brenda Cassellius, Ed. D.

1:1 Device Programs Best Practices in K-12 Education

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Report to the Legislature

Cost of Report Preparation

The total cost for the Minnesota Department of Education (MDE) to prepare this report was approximately $15,086.46. Most of these costs involved staff time in analyzing data from surveys and preparing the written report. Incidental costs include paper, copying and other office supplies.

Estimated costs are provided in accordance with Minnesota Statutes 2011, section 3.197, which requires that at the beginning of a report to the Legislature, the cost of preparing the report must be provided.
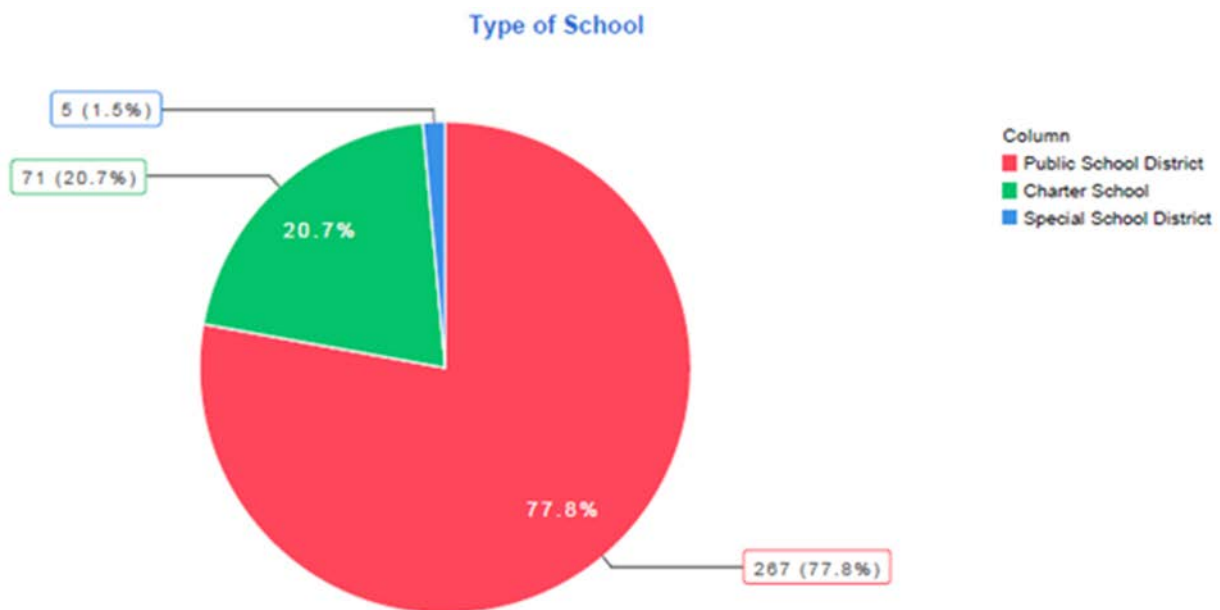
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Legislative Charge

The commissioner of Education must research existing 1:1 device programs in Minnesota and across the country to determine best practices for Minnesota schools implementing 1:1 device programs. By February 15, 2016, the commissioner must develop and publish guidelines to ensure maximum effectiveness of 1:1 device programs and make a report on the research findings to the committees of the Legislature with jurisdiction over kindergarten through grade 12 education. (HF1, Art. 6, Sec. 8 (First Special Session, 2015))

Executive Summary

One device to one student (1:1) programs has grown organically for the past twenty years. Approximately 55 percent of Minnesota schools now have some level of a 1:1 program. Over the next year, another 30 programs are projected to start, and a number of existing programs are expanding. The majority of these programs started in the last three to four years. While pioneering districts have provided guidance and support for other districts, uniform guidance and support from the state does not exist. This report will provide guidance in the form of research regarding programs throughout the state and nation.

Type of School

5 (1.5%)
71 (20.7%)
20.7%
77.8%
267 (77.8%)

Column
■ Public School District
■ Charter School
■ Special School District

As districts initiate 1:1 programs, they should consider a range of issues, including infrastructure, management, leadership, curriculum and instruction, funding and professional development. Due to the wide range of considerations, a leadership team with different areas of expertise is one of the strongest contributors to fully realizing an effective program.

While data indicates there is not one issue that would preclude statewide implementation of a 1:1 program, due to an inequity of technology funding, broadband access, and staffing, programs are not always delivered effectively. Among the most needed system supports is providing state and broad local support for leadership and building infrastructure around

professional recommendations. This report provides data and research to support recommendations to meet the needs to implement a successful 1:1 device program.

Research on Minnesota Programs

History in Minnesota

The first large 1:1 initiative in Minnesota took place in Minneapolis Public Schools. In 1998, the senior classes at North High and Washburn High received laptops. The program only lasted several years, and started pre-Wi-Fi, pre Google and pre "Apps." The next generation of larger 1:1 programs took place in Hopkins Public Schools and Stillwater Area Public Schools in the early 2000s. These were also laptop programs, but unlike Minneapolis, Hopkins and Stillwater were able to take advantage of wireless technology, nonexistent in 1998 when Minneapolis started their program.
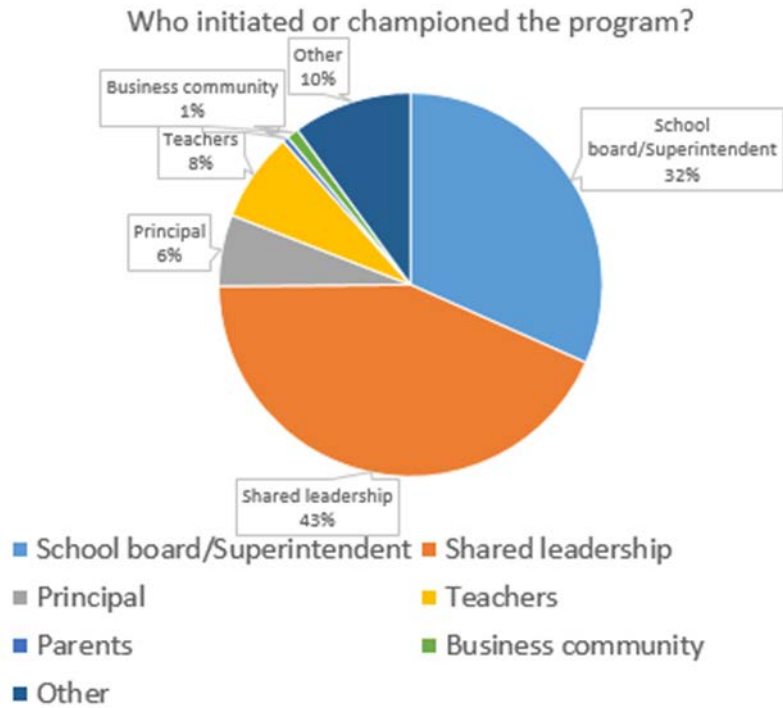
The production of the iPad almost six years ago ushered in a new opportunity for 1:1 programming. The first large iPad (tablet) 1:1 programs started in Little Falls Public Schools, West St. Paul School District, Minnetonka Public Schools and Gibbon-Fairfax-Winthrop School District. These programs continue to this day. The single largest 1:1 program in the state is in the St. Paul Public School District.

The schools and districts that were the pioneers in the state, helped pave the way for today's 1:1 programs. Those first programs did much of the early work in proving the elements required to maintain an effective 1:1 program. One of the most significant trends reported in the survey is the rapid growth of 1:1 programs, a majority of which have started in the last three to four years. Approximately 55 percent of Minnesota schools now have some level of a 1:1 program, and over the next year it is expected that 30 more programs will start around the state and a number of existing programs will expand. This data was collected through the survey provided to all districts in Minnesota. Additional information from around the state is found in this report.

Leadership

"There is an increasing concentration of mobile learning devices in classrooms, a rapidly emerging educational technology pedagogy expectation for teachers, and changing expectations of district leadership in our educational institutions." (Tryggestad 2015, p. 142-143)

Of the approximately 55 percent of Minnesota school districts and charter schools participating in some type of 1:1 initiative, more than 80 percent of those districts have indicated that the school and district leadership are leading the vision for 1:1 initiatives, as the graphic demonstrates. The largest majority of those initiatives are being championed by shared leadership.

Who initiated or championed the program?

Category	Percentage
School board/Superintendent	32%
Shared leadership	43%
Principal	6%
Teachers	8%
Parents	
Business community	1%
Other	10%

Shared leadership initiated the largest percentage of programs. In most cases the shared leadership was inclusive of teacher leaders and administrators (either a principal or curriculum director). Other district programs were more inclusive of their shared leadership. One district, which had a committee of teachers, administrators and educational assistants, shared their plan with a series of community meetings to bring parent and community members input into the implementation. The other respondents were largely more recent superintendents who did not have the historical perspective to the beginning of the work in their district.

The leadership was cited in many of the district responses as critical to effectively implementing programs. Providing each student with a device helps to close, but not eliminate, the digital divide. Other programs have been driven through technology and lack connections with curriculum and instruction and thus programs struggle. Some districts have said these programs focus too heavily on devices and not enough on curriculum and teaching. District and school leaders need to be mindful of the leadership in the planning of a 1:1 program.

Infrastructure

High-speed broadband access, efficient internal networks, robust Wi-Fi systems and the people necessary to manage the infrastructure and deploy the devices are necessary for the success of any 1:1 initiative. While studies, debates and discussions about 1:1 initiatives focus on funding, the type of devices to deploy and device management and filtering, there seems to be a lack of focus on infrastructure as being necessary to support such a deployment in a school setting. In a University of Maine study of a statewide initiative in Maine high schools, it was noted that, "The infrastructure in place to support the devices, including the all-important technology support staff, appears to be more important to the success of a 1:1 program than the type of

device deployed" (Walker, Johnson, Silvernail, 2011) In Minnesota, where there is no statewide network and funding specifically for technology infrastructure is limited (see funding section for more information), districts are required to fund a portion of their infrastructure needs and a majority of their support staffing through general education funds and other sources. This creates a disparity in the quality and effectiveness of school district networks and other aspects of technology infrastructure.

There is very little comprehensive data available on infrastructure and technology staffing in Minnesota schools. Education Superhighway, a non-profit organization whose stated mission is to "(u)pgrade the Internet access in every public school classroom in America so that every student has the opportunity to take advantage of the promise of digital learning" provides an infrastructure report based upon information provided in district E-rate applications combined with some follow-up interviews with specific districts. Their report, made public at a meeting of the Governor's Task Force on Broadband in October 2015, gives some insight on how Minnesota districts, without a statewide network for schools, provide Internet access to their students and staff:

- 73 percent of Minnesota's public school districts (not including charter schools) receive their Internet access through a consortium. These consortia include service cooperatives, regional management information cooperatives, telecommunications cooperatives and other special cooperatives. The consortia often aggregate the purchase of Internet access for a more efficient and cost-effective model.

- 9 percent of districts receive service from consortia but purchase Internet service on their own.

- 18 percent of districts self-procure Internet access and have no (or very little) contact with a consortium.

As a major component of this report, the Minnesota Department of Education (MDE) provided a survey to all Minnesota public schools in September 2015. The survey provides a qualitative look at infrastructure and staffing relative to existing or potential 1:1 initiatives. In that survey, 339 public school districts and charter schools responded, resulting in a response rate of over 68 percent. Following are some results from the survey that provide insight into how Minnesota schools view the adequacy of their infrastructure and staffing.

Internet Bandwidth

The State Educational Technology Directors Association (SETDA) recommends that all schools provide 1 Gigabyte per second (Gbps) of Internet bandwidth per 1000 students/staff by 2018. Education Superhighway estimates that 22 percent of Minnesota schools do not yet meet 2014 goals, and less than 19 percent of Minnesota schools meet the 2018 goal. While many Minnesota schools do not yet reach these goals, many, through cooperative arrangements and individual procurement, are able to obtain bandwidth to meet their current needs. In the statewide survey, 85.1 percent of districts and charter schools indicated they strongly agree or agree that their Internet bandwidth is adequate to meet current needs.

However, that number drops to 62.7 percent when asked if the Internet bandwidth is adequate to meet expansion of their technology initiatives. This indicates that over one-third of Minnesota schools do not feel they have the necessary Internet bandwidth to address their technology use and deployment plans moving forward.

Wi-Fi

Education Superhighway, in their "Network Essentials for Superintendents" guide, recommends an average of 1.2 Wi-Fi access points per classroom to support a robust 1:1 initiative. While there are currently no statistics available for the average number of access points, the statewide survey does indicate that 77.5 percent of districts and charter schools either strongly agree or agree that their Wi-Fi capabilities are adequate to meet current needs.

As with Internet bandwidth, the numbers again drop to 51.6 percent when asked whether Wi-Fi infrastructure is adequate to meet future needs. Thus, nearly half of Minnesota schools will need to upgrade their Wi-Fi infrastructure to support expansion of 1:1 and other technology initiatives.

Staffing

The statewide survey shows that over 80 percent of the school districts and charters that responded have less than one licensed staff person per building to support their technology initiatives. While this does not account for unlicensed technology support personnel, it may suggest that schools are not making significant investments in integration personnel with the educational skills necessary to guide teachers in best educational practices for using technology in their classrooms.

Schools also feel less positive about their general technology support than broadband and Wi-Fi. 48.1 percent of districts and charter schools either strongly agree or agree that they have adequate technology staff to deploy technology, including 1:1 initiatives, in their schools today. Only 43.6 percent feel the same way about adequate staff for ongoing management of technology initiatives. This shows that well over half of Minnesota schools feel they lack sufficient technology personnel to effectively deploy or manage 1:1 or other technology initiatives in their schools.

Funding

Infrastructure Funding in Minnesota

There are only two sources of funding dedicated to Internet access, LAN/WAN equipment, and other broadband related services in Minnesota: the federal E-rate program, and a state program referred to as "Telecommunications Internet/Access Equity Aid." All other funding for technology infrastructure in Minnesota schools comes from local sources.

E-Rate is a federal program that provides discounts to help schools and libraries obtain affordable telecommunications and Internet access.

The E-Rate program has two funding categories. Category 1 funds Internet access, the cost of fiber optics or other means of transporting data, and some local and long-distance voice/telephone services. Category 2 funds wireless access points, firewalls, routers, switches

and other similar equipment used to distribute Internet access within a school building. Funding covers all Category 1 requests before considering Category 2 requests.

With the E-Rate program capped at $2.25 billion, many schools that were not high need did not have their Category 2 requests covered. However, recently, the FCC allocated an additional $1.5 billion to the program for each of the next five years for an annual total of $3.75 billion. The FCC recognized that not only do schools need help affording bandwidth, but they need to improve their infrastructure, especially their Wi-Fi capabilities.

Schools apply annually for E-rate discounts by providing documentation of costs incurred for services that have been procured through competitive bidding, through statewide negotiated contracts or at tariffed rates. The level of funding provided is based on a school district's percentage of students eligible for the National School Lunch Program (NSLP), commonly referred to as "free and reduced-price lunch."

In 2014, Minnesota schools received over $32.7 million in E-Rate reimbursements. That represents about 1.4 percent of the national total. In the same year, because of the budget cap for the program, $8.5 million in requests for eligible expenses by Minnesota schools went unfunded because the program, prior to this year's increase, did not have sufficient funding for most Category 2 services.

Education Superhighway estimates that 26 percent of Minnesota districts do not have fiber-based networks between their school buildings, which is necessary for districts to support technology initiatives such as 1:1. The new E-rate funding and rules make it possible for nearly all districts to receive some funding toward improved fiber connectivity and infrastructure. However, the E-rate program does not cover all of the ongoing costs of broadband connectivity. Also, there continue to be inequities in costs to deliver Internet access (bandwidth) to different parts of the state. Education Superhighway's research indicates that, when compared to each other, districts in the 10th percentile pay an average of $245 per month for a 1 Gbps fiber WAN circuit where districts in the 90th percentile of costs pay an average of $2000 per month for the same capacity fiber WAN circuit. For Internet access charges, costs can vary from one part of the state to another by more than 500 percent.

Telecommunications/Internet Equity Access Aid (TEA) is a state program (Minnesota Statute § 125B.26) that provides school districts and charter schools with financial assistance to help with the costs of maintaining Internet access, video connectivity and related telecommunications services as defined on the federal E-Rate Eligible Services List as recurring Category I services. A school district or charter school's telecommunications/internet access equity aid equals the approved cost for the previous year that exceeds $16 times the adjusted marginal cost per pupil units (AMCPU) for the previous year OR reimbursement of approved costs with no per pupil unit limit if the school district or charter school is a member of an organized telecommunications access cluster that was in operation by July 1 of the previous funding year.

This program provides reimbursements for the portion of actual eligible costs incurred after E-Rate discounts and covers only a limited number of eligible telecommunications services. TEA

funding is legislatively capped at $3.75 million annually. Most recently, actual costs incurred by Minnesota schools (after E-Rate reimbursement is applied) for TEA eligible expenses have approached $9 million. The costs of broadband and Internet access are rising due to school district needs for additional bandwidth and services to support learning when education resources and connections are increasingly accessed online.

The result is a $5 to $6 million (and rising) gap between what it costs Minnesota school districts to provide Internet, data, video and related telecommunications services after E-rate discounts and what is funded.

1:1 Project Funding in Minnesota

One to one programs are funded through other means. In the survey it was identified that Minnesota school districts fund their 1:1 and mobile device initiatives in a variety of ways. One hundred eighty-nine public school and charter districts with 1:1 initiatives reported they fund their projects with a combination of the sources shown below:

Source	Respondents
Local Funding	125
Levy/Referendum	63
Grants	31
Special Funding (fundraisers, PTO, etc)	22
Federal Funding	16
Other	14
Subsidized Personal Purchase	10
Corporate Support	7

One hundred twenty-five, or 66.1 percent, of the districts in Minnesota with 1:1 initiatives are funding them, at least in part, through local funding sources, typically from the general education formula. Sixty-three, or 33 percent, of the districts, at least partially, fund the programs through a local levy or referendum. Schools find local funding sources in one or more ways: eliminating or delaying textbook purchases, utilizing leasing programs for technology purchases to spread payments out over multiple years, or reducing costs in other areas.

In the statewide 1:1 survey, districts that do not currently have 1:1 programs were asked to provide reasons why they do not have such programs. Nearly 34 percent responded that it was due, in part, to a lack of funding, the most frequent response given. Comfrey Public Schools stated, "as a small school, we struggle with basic costs." Others do not see the initial costs as a barrier, but are concerned with sustainability. Warren-Alvarado-Oslo School District stated they "could afford the initiative, but don't know if it can be sustained." Benson Public Schools agreed

that they would "only go forward with a 1:1 (program) when district has funding to sustain long term."
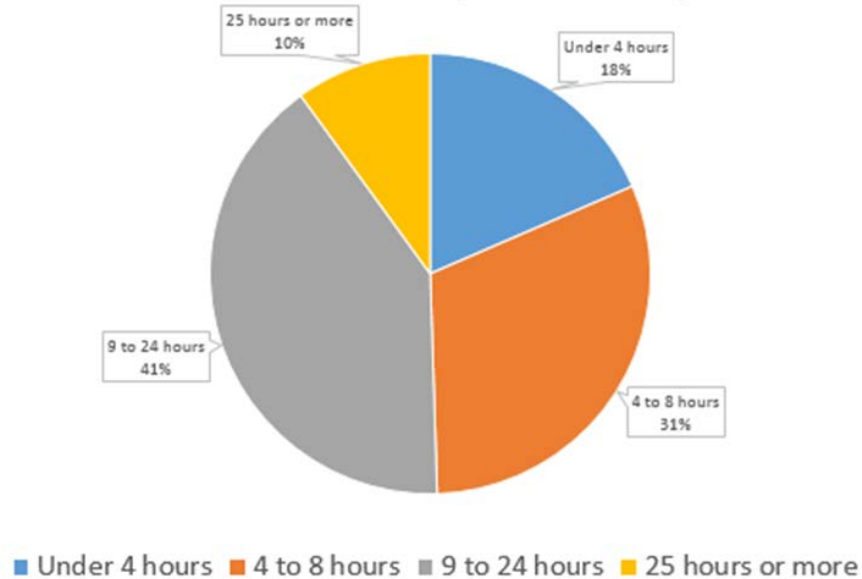
Professional Learning

Having high-quality continuing staff development (professional learning) focused on technology integration for teachers, paraprofessionals and substitutes is also a critical component of 1:1 initiatives.

Professional development with high-quality, hands-on training will be as much about the technology as about refinements in pedagogy and digital learning materials. High-quality professional development allows time for practice and follow-up, challenging tasks and strong ongoing instructional technology coaching as teachers improves in their practice. This is as important for the changes in pedagogy as it is for the applied use of technology and digital resources. High-quality professional development is collaborative, allowing teachers to work and learn with their peers.

This type of high-quality professional development creates frameworks for teachers to explore and determine the best and most appropriate resources to use. It allows teachers to assess the quality and applicability of the rich resources available online and how to share resources with others. This high-quality professional development will create organic environments where teachers share their best practices and celebrate high-quality integration of technology to accelerate student and teacher learning.

On the Minnesota Statewide 1:1 Initiative Survey (September 2015), districts were asked how much time was allocated annually for professional development to support 1:1 work. Of the 201 districts who responded, 18.9 percent stated that they allocate less than four hours annually. Sixty-two districts (30.8 percent) responded that they allocate four to eight hours annually and 40.3 percent stated that they provide nine to 24 hours. Only 10 percent of districts responding said they provide 25 or more hours annually for teacher staff development focused on supporting 1:1 initiatives.

How much time is allocated for professional development?

- Under 4 hours 18%
- 4 to 8 hours 31%
- 9 to 24 hours 41%
- 25 hours or more 10%

■ Under 4 hours   ■ 4 to 8 hours   ■ 9 to 24 hours   ■ 25 hours or more

Districts were asked if the time allocated for professional development in the prior question was adequate. The majority of those responding, 58.5 percent said "no." Twenty-nine districts responded "other" and added the following comments:
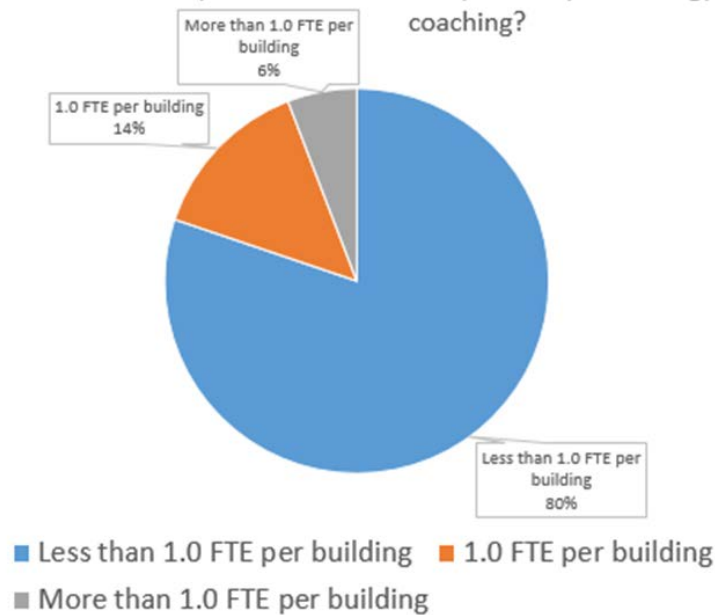
- There is never enough time.

- With all other required professional development and teacher evaluations, there is not adequate time left for professional development to support 1:1 work.

- Even when paid staff development time is provided, some teachers do not participate.

- We need more "on-demand" support.

- This is a large shift in the process of teaching and is difficult.

- Our district does a curriculum development year prior to grade level implementation.

Is professional development time adequate?

Other 13%
Yes 18%
I don't know 11%
No 58%

Yes ■ No ■ I don't know ■ Other ■
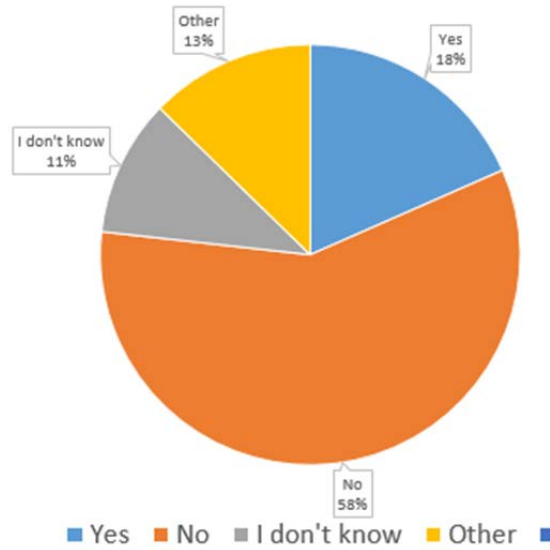
Districts were asked how many licensed technology integration coaches or other licensed support staff was provided, by building, to support 1:1 work. While many districts commented that they had non-licensed technology support, only 19.8 percent stated they had 1.0 or more licensed full-time equivalents (FTE) per building specifically assigned to supporting 1:1 work.

How many licensed FTE staff is specifically technology integration coaching?

More than 1.0 FTE per building 6%
1.0 FTE per building 14%
Less than 1.0 FTE per building 80%

■ Less than 1.0 FTE per building ■ 1.0 FTE per building
■ More than 1.0 FTE per building

Below are several examples of how a small portion of Minnesota school districts are providing professional development in their 1:1 programs. The following are excerpts from conversations

with several school districts. Elements of these programs can be found in many one to one programs throughout the state.

Greater Minnesota District A

Greater Minnesota District A has enrollment of 1,650 students and over 30 percent are eligible for free or reduced-price lunch.

The district superintendent stated that their 1:1 implementation covers grades K-12. In their planning stage, they realized they needed to move from contracted technology support to a fully staffed technology department, including a network engineer/technology director, hardware specialist/technology coordinators and a licensed teacher/technology integrationist.

They are following the Substitution, Augmentation, Modification and Redefinition (SAMR) model, developed by Dr. Ruben Puentedura.

In "Phase I," teachers were asked to get comfortable using their mobile devices. Teachers were only required to provide evidence that they were using them to do tasks. During staff workshops, each teacher was required to give a five to 10 minute "TED Talk" on a tool they learned to use. They were encouraged to bring their devices home and use them for personal tasks in addition to any uses they had in their classrooms. They were encouraged to use them to take notes, to use them to send emails to coworkers or parents and use them to open documents instead of printing them.

In "Phase II," they were encouraged to do the same but expand the application features that they used. Currently 70 percent of the teachers are in the Modification-Redefinition phase. They are using technology to significantly redesign their instruction and create curriculum previously not thought possible.

The superintendent said that their teachers have many options for technology staff development, including, but not limited to:

- A summer program where technology integration is the focus. Between 70-80 percent of their teachers participate in this paid summer program. Teachers who do not come in over the summer are required to attend this training during their back-to-school in-service days.

- Each Wednesday, students have a 1.5 hour early release and teachers use this time to work on technology. Technology staff are available if they have questions.

- For the last three years the district has hosted a "Professional Development Summit". This is a full-day conference, coordinated with other districts. It is held a week or so before the start of school. Teachers from neighboring districts are bussed into the high school to participate in over 60 breakout sessions focused on technology and teaching. The summit kicks off with a guest speaker and ends the day with a keynote speaker to get teachers geared up for the new school year.

The district is also a member of the Minnesota Partnership for Collaborative Curriculum (MPCC). This is a grassroots collaborative started to develop comprehensive open education resources (curriculum, lesson plans, class activities, etc.) by Minnesota teachers, addressing Minnesota standards for Minnesota schools. This summer they hosted six districts for MPCC training. Teachers learned not only how to use these resources, but how to integrate them into the classroom. The superintendent stated that the district has purchased its last set of curriculum and will focus its resources on becoming creators of curriculum and not consumers.

Greater Minnesota District B

A second greater Minnesota district has 650 students, over 30 percent of whom are eligible for free or reduced-price lunch.

The technology director stated that the 1:1 program covers grades three-12 with a technology department consisting of one full-time technology director and one part-time assistant. The implementation of 1:1 did not come with an increase in technology staff or an increase in the technology budget, therefore their approach to staff development is different than most districts.

The district provided focused staff development on Google Apps for Schools the year prior to their 1:1 initiative. An education consultancy organization provided training sessions for all teachers this year. They encouraged their teachers to seek self-guided training through the internet, YouTube, and other relevant applications. Teachers have administrative rights to their devices and can add apps as they need them. Technology integration is happening organically and teachers share success stories with each other.

Greater Minnesota District C

A third greater Minnesota district has 2,360 students, over 40 percent of whom are eligible for free or reduced-price lunch.

The technology director stated that they are 1:1 for grades 3-12. During the first two years they set aside five days at the end of August for teacher staff development on mobile devices. Instruction was delivered in the morning and teachers were able to use afternoons for prep. If there were flaws in the model, it was that it was too much information at once and teachers got overwhelmed. It was at the beginning of the school year and many teachers were preoccupied with getting ready for the school year. Placing all of the training in August isn't effective because they aren't ready for advanced topics until later in the school year or they may have forgotten the materials. The technology director feels they needed consistent training throughout the school year. He also feels that training is best offered by classroom teachers from a similar grade level or department.

Moving forward, three in-service days were added to the calendar. They ask teachers to complete a survey prior to the i-service day to pick technology topics. Survey results are compiled and the top three or four topics per building are selected. Teachers willing to present on those topics are recruited and paid for two days of curriculum writing.

Greater Minnesota District D

A fourth greater Minnesota district serves 4,100 students, 40.5 percent of whom are eligible for free and reduced lunch.

The Assistant Superintendent of Teaching and Learning stated that they have 1:1 initiatives in grades four-six and nine-12. Next year they will be in grades two-12. Teachers receive the same devices their students have along with a Macbook Pro. In order to receive their equipment, staff must attend a 1.5-day training session that includes an introduction to the devices, Google training, training in a blended learning environment and Moodle training.

They have two Apple certified integration coaches who provide additional training based on teacher requests.

Paraprofessionals and substitute teachers are also included in their training and the Community Education Program provides iPad training for parents and the larger community.

Metro District A

Now in its fifth year, a metro district has expanded its iPad program from one grade level to eight. Their approach was to carefully match both technical and instructional support for teachers as the program evolved and grew. Having learned from many other 1:1 programs how important professional development is to success, the district was very deliberate in its design and delivery of professional development. This proactive approach allowed their teachers to transition learn and take risks in developing their ability to powerfully teach with digital tools.

A district leader stated "training should be relevant, frequent, and differentiated. We have found great success with small group meetings held before, during, and after school. Sometimes teachers meet by grade level and content area, and other times by ability and interest. Providing teachers with opportunities to connect, collaborate, and brainstorm ideas have advanced the level of technology integration we see on a daily basis in our 1:1 program."

Their model, like many others, uses a variety of means to deliver training and support to teachers. Their model includes late summer and early fall formal classes, before and after school classes, and includes ongoing coaching on pedagogy, instruction and technology throughout the school year. The Technology Coaches are all teachers and all teach at least one content area class throughout the school year, giving the coaches a strong applied practitioner perspective that informs the coaching of their fellow colleagues and faculty. As able and appropriate, staff attend external training opportunities and bring their learning back to the district to share with their colleagues.

Research on National Programs

A survey of national research identifies elements and practices that focus on procedure, infrastructure and leadership.

Leadership

A significant amount of work has been done to identify the frameworks and conditions necessary for the successful use of technology in today's classroom. Much of this work has

been done by the [International Society for Technology in Education (ISTE)](#) and the [Consortium for School Networking (CoSN)](#). Three of the most common examples are provided below along with a description of the work as provided on the site's page.

- [ISTE Essential Conditions](#)
    - "The ISTE Essential Conditions are the 14 critical elements necessary to effectively leverage technology for learning. They offer educators and school leaders a research-backed framework to guide implementation of the ISTE Standards, tech planning and system-wide change."
- [ISTE Standards for Administrators](#)
    - "In this time of rapid change, school and district leaders are more important than ever. The ISTE Standards - A guide administrators in supporting digital age learning, creating technology-rich learning environments and leading the transformation of the educational landscape."
- [Framework of Essential Skills for the K-12 CTO](#)
    - "The [Framework of Essential Skills of the K-12 CTO](#) is comprised of three primary professional categories that sum up the work you do in the education technology field. These categories encompass 10 specific skill areas which outline the responsibilities and knowledge needed to be a viable educational technology leader."
- [The Empowered Superintendent](#)

"Superintendents can make or break educational technology initiatives. They are responsible for ensuring that their school districts embrace transformative digital learning. CoSN collaborates with superintendents to assess their challenges and increase their capacity to lead technology efforts. We're dedicated to helping superintendents, aspiring superintendents, and district leadership teams build their knowledge, skills, and confidence."

When used together, these resources can provide districts with the skills, conditions, and environments necessary to help district leaders work collaboratively to implement effective technology use by students.

Research from the Texas Technology Immersion Program indicated that schools that took the time to thoughtfully plan out the initiative and implementation had a higher success rate than those schools that were not afforded that opportunity (Shapley et al 2010). Additional research that examined data from programs in North Carolina by Oliver et al suggests that school leaders must be willing to accept and take on five roles when preparing for a 1:1. They must be learners, motivators and change agents, instructional leaders, purveyor of resources, and evaluators.

The underlying idea is that these types of initiatives cannot be rushed. A clearly articulated purpose must be developed and delivered by leadership to all involved. The district's network infrastructure and access must be robust. Professional development on how to engage students in meaningful learning utilizing technology is essential to success. A thoughtfully designed approach that includes all district stakeholders is extremely important and necessary to the overall success of the initiatives.

Infrastructure

Access to high-speed networks and broadband services is a vital component of K-12 school infrastructure.1:1 and other mobile technology initiatives must have robust network and broadband infrastructure in place if they are to succeed.

Around the nation, public school districts choose to provide this infrastructure in a number of ways. According to data collected by the State Educational Technology Directors Association (SETDA), 31 of 50 states have some type of statewide network to provide wide area network (WAN) and/or Internet services to public school districts. The remaining 19 states provide these resources through a combination of regional networks, other cooperative arrangements or individual district procurement.

Where statewide networks exist, services offered may include WAN access, Internet service, e-mail, web hosting, distance learning, video services, technical support and more. Funding for the network may come from any combination of state legislative appropriations, federal E-rate funding, grants, membership fees, service fees or other state or local programs.

Examples of State Networks

In Maine, a collaboration of several state institutions created NetworkMaine, a consortium made up of the Maine Department of Education, Maine State Library, Maine Office of Information Technology and the University of Maine System. The network provides broadband connectivity at speeds ranging from a minimum of 10 Mbps to a high of 1 Gbps in some locations. The Maine School and Library Network (MSLN), a service of NetworkMaine, is a consortium consisting of almost 1000 schools and libraries across the state, through which participants acquire Internet access, local loop circuits and other related services. The consortium was unofficially formed in 1996 when a rate case against NYNEX funded Internet access to all schools and libraries in Maine. Services provided by MSLN are paid for using a combination of funding from the federal E-Rate program (approximately 60 percent of the cost) and the Maine Telecommunications Education Access Fund (approximately 40 percent of the cost). Funds are generated through an assessment on interstate phone bills for the federal E-Rate portion and on intrastate bills for the MTEAF portion. MSLN has an annual budget of approximately $8 million.

The Utah Education Network (UEN) is a partnership of public and higher education institutions with local telecommunications providers that connects all of the state's schools to the Internet through a statewide network. A high-capacity backbone connects all of the colleges and universities in the state through middle-mile fiber segments. Ninety-nine percent of the state's K-12 schools connect to that backbone and receive Internet services through the network. All public colleges and universities connect at 1 Gbps or faster. Most public high schools and middle schools connect at similar speeds. The current major sources of funding for high-speed/broadband connectivity for schools are state appropriations, E-Rate, and federal grant programs. The annual budget for the K-12 portion of UEN is approximately $24 million.

Network Nebraska-Education (NNE) is a partnership of entities from K-12 and higher education, public and private, which aggregate their purchases to provide a high-speed backbone, statewide Internet access, network management, equipment co-location, procurement services, E-rate filing and technical support. It is the primary transport mechanism for web-based and video distance education, and rich media content distribution. Created in 2006 through Legislative Bill 1208, the State Office of the CIO, assisted by the University of Nebraska, manages this network. NNE is utilized by 99.6 percent of all K-12 public school districts in the state. Members of the network self-fund it with membership and participation fees. NNE utilizes

federal E-Rate funding on eligible services to reduce the costs to individual districts. The annual budget for NNE is approximately $1.2 million.

The [State Education Policy Center (SEPC)](#) has more information on state networks.

Having access to a wide area network and some level of Internet access alone does not ensure the success of any 1:1 or mobile device initiative. For the infrastructure to support these initiatives, the speed of the network and the Internet bandwidth must be sufficient. A 2014 report by Education Superhighway, "Connecting America's Students: Opportunities for Action," provides some background on the national broadband scene in schools.

> *Today, 99 percent of America's K-12 public schools and libraries are connected to the Internet. This is a testament to the success of the Federal Communications Commission's (FCC) Congressionally-mandated E-rate program, which has provided technology funding to schools and libraries since 1998. However, as a new generation of education technology and digital learning opportunities enter the classroom, basic Internet connectivity is no longer sufficient to educate and prepare America's children for the modern age. To ensure that all students receive a high quality education and are prepared to compete in today's global economy, our schools and libraries need high-speed broadband and ubiquitous Wi-Fi.*

> *Increasing adoption of one-device-per-student ("1to1") learning models, online classes, streaming video content, live video chat, and other online educational software has made technology essential to the 21st century classroom. In making these digital learning opportunities available to more students, schools' need for bandwidth is growing 30 - 50 percent per year. Recognizing the importance of bringing schools up to speed in the Internet age, President Obama announced the ConnectED initiative in June 2013, establishing a goal to connect 99 percent of students to high-speed broadband within five years.*

> *To meet the objectives of the ConnectED initiative, each component of a district network needs to be upgraded to minimum bandwidth standards that ensure the delivery of high-speed Internet to students' desks. Networks should also be designed to be future-proof to enable higher minimum standards in the future as bandwidth needs increase.*

The State Educational Technology Directors Association (SETDA) has four recommendations to address the K-12 education infrastructure needs that will provide robust networks and the high-speed Internet access vital to the success of 1:1 and mobile device initiatives.

1. Move to Address K-12 Broadband Infrastructure Needs (Adopt the ConnectED Connectivity Standards)

   These goals are now used by Education Superhighway in their efforts to improve broadband access in schools and by the FCC.

   a. 2014-2015 target for external Internet connection to an Internet Service Provider (ISP) of at least 100 Mbps per 1,000 students/staff.

b. 2017-2018 target for external Internet connection to an Internet Service Provider (ISP) of at least 1 Gbps per 1,000 students/staff.

c. 2014-2015 target for internal wide area network (WAN) connections from the district to each school and among schools within the district of at least 1 Gbps per 1,000 students/staff.

d. 2017-2018 target for internal wide area network (WAN) connections from the district to each school and among schools within the district of at least 10 Gbps per 1,000 students/staff.

Broadband is the enabling technology of modern learning environments, and broadband concerns should never be a factor when teachers or students are planning for educational activities. Unless we swiftly and systematically move to address the impending bandwidth dearth facing schools nationwide we will find it to be the limiting factor in school reform and improvement.

2. Ensure Broadband Access for Students and Educators

   SETDA recommends the federal government, states, and districts take responsibility for ensuring easy access to robust broadband connectivity outside of schools including, but not limited to, the home and publicly accessible institutions such as libraries and community centers.

Home access to broadband is arguably as important to the overall quality of the learning experience as access at school and is key to extending learning time. Thanks to the proliferation of low-cost laptops, tablets, and smartphones— and the rise of state and district high-access and 1to1 programs— teaching and learning is no longer limited to the confines of a school building or a school day.

3. Build State Leadership

   State leadership is essential to the process of providing adequate and equitable bandwidth. SETDA recommends all states provide direct leadership in the development and implementation of programs to provide adequate and equitable bandwidth to K-12 schools, homes and publicly accessible institutions such as libraries and community centers.

4. Advocate for Federal Funding

   SETDA recommends the federal government increase funding options to support a)states in implementing and maintaining high-speed broadband, statewide networks, b) districts and schools in increasing bandwidth capacity, c) communities in providing access points at anchor institutions including, but not limited to, libraries and community centers, and d) low-income families in providing home broadband access.

The U.S. ranks 15th among industrialized nations in the availability of high-speed Internet access. Bandwidth to homes and schools in Taiwan, France, South Korea, Sweden, and Japan

is generally greater and more widely available than it is in the U.S., because the governments of those countries support national efforts to increase broadband access at affordable prices, including public Wi-Fi. For example, some areas of Seoul provide commercial Internet speeds of more than 100 Mbps for merely $30 per month. With this type of speed, a consumer can download an entire HD movie in five minutes— a process that can take two hours or more in the U.S., even in densely populated cities. Yet the South Koreans pay less than U.S. citizens do for Internet service.

Management

Significant recent advances in device management by companies like Apple, Google and Microsoft have allowed both greater flexibility and greater security for 1:1 programs. In addition to security, a number of leading device manufacturers have provided tool sets for over the air (OTA) administration of wireless devices. This allows for more efficient deployment and management of devices as well as pointing to a promising future where student devices are retained and used beyond the traditional academic school year. This holds promise for helping all students make continual academic gains, even over the summer months.

While it has been possible for many years to remotely manage desktops and laptops with technical systems that are very mature, this new era of mobile device management (MDM) has been rapidly maturing due to the popularity of mobile computing. In just the last year, significant efficiencies and functionalities have been added to several major mobile platform management tools. For example, it is now possible to securely lock student devices such that only predetermined sets of applications can be installed and used. This was not the case several years ago. Another manufacturer has recently made their device essentially unusable by anyone other than the organizational owner of the device, should that device be stolen.

Historically, school districts have struggled to manage software licenses from year to year, often having to purchase the same licenses from one year to the next. Again, within the last several years, the mobile device management environments along with application providers, now allow for licenses to be used and repurposed from year to year, thus saving organizations and schools considerable costs associated with software. Most impressive over the last several years is the incredible proliferation of mobile applications. It is common for a school' 1:1 program to have several dozen applications that are used routinely by students and teachers, and dozens more that are used as-needed for specific tasks, subject areas and content gathering.

While there have been significant technical improvements in the management of student devices, there have been parallel gains in literacy specific to digital citizenship, parent involvement and how to best strike a healthy balance in the use of technology. Formal organizations like Common Sense Media, along with numerous grassroots and district efforts to involve communities in conversations around appropriate technology use, are helping with those elements of computing that go beyond a technical solution. Students and families are learning what makes for a good digital footprint, how to be a responsible technology user and how to have a healthy balance of technology in one's personal life. And while these areas are not new

to education, a tipping point has been reached in 1:1 programs for educating the broader community regarding the balance between digital technology use and citizenship.

The management of curricular resources and workflows associated with using digital resources has become significantly easier to deploy and manage. In modern 1:1 programs, technology has allowed for much faster and even personalized iterations within the teacher and learning cycle. Choosing and assigning materials, collaborating on projects and assignments, turning in, grading and returning work have all become easier. For example, when all students are accessing a personal device, a teacher can thoroughly and effectively check for understanding many times throughout a single classroom.

And while there have been gains in the area of digital citizenship due to the growth of 1:1 programs and the increase of the place of social media, there have been parallel gains in the area of teacher instructional practices related to best use, classroom management and overall school and district management of one to one programs.

Curriculum, Instruction and Assessment

In the book District Leadership that Works, authors Robert Marzano and Timothy Waters found a strong correlation between the two key variables of non-negotiable goals for instruction and assessment of progress towards those goals. In their meta-analysis, they found that clear goals related to instructional improvement and consistent monitoring of those goals is important to the improvement process. The authors concluded that across 2,714 school districts, clear goals and consistent monitoring and assessment were among the top five strategies related to improved achievement. Similarly, clear goals and assessment relate to successful impacts of technology on classroom experiences.

The instructional goals of 1:1 initiatives vary greatly, as do the targets of assessment and results of studies. Technology can be utilized in nearly any content area and across multiple instructional strategies. In addition, the shifting environment of digital content and tools contribute to a broad array of strategies and results. What follows is a description of common focus areas of 1:1 initiatives across the United States, and a description of the results when available. Based upon the number of school districts presumed to have 1:1 programs and the much smaller pool of available research, it is likely that many districts do not have rigorous research studies conducted that describe the results matched to the goals.

Student Achievement on Standardized Assessments

Educators debate the impact of educational technology on student achievement scores. . While opinions vary, the research provides insight into many independent variables that lead to a difficult and complex answer.

In a 2005 Hanover Research Report that examined case studies of seven school districts pertaining to student achievement on standardized assessments, the report's data painted an inconclusive picture of the correlation between technology use and improved scores. More recent studies point to similar results, and many of the authors discuss the need for

broader assessment on multiple conditions in addition to student achievement on standardized tests.

Student Engagement

The definition of student engagement varies; it can range from emotional engagement to intellectual engagement. However, studies of the variety of types of engagement for high school students show a very concerning trend: increasingly, students do not feel that they matter to their school community. Schools across the nation are looking past the core curricular areas and seeking ways to integrate technology to bolster student engagement by providing experiences that connect children to their peers, mentors, and the rest of the world and to ask them to do real-world tasks that involve, in part, the use of a variety of digital tools. Many of the research reports in literature include students self-reporting improvements in engagement.

Digital Curriculum

While predictions about the future of educational technology can be difficult with the frequent changes in technology, one driving factor for 1:1 adoptions is a move to accommodate the increase in digital curriculum materials. For years, textbook vendors have been adding supplemental digital materials to the traditional paper-based material offerings. Within the last five years, curriculum materials have begun to appear increasingly in all-digital formats. It is a safe assumption that the use of digital materials will increase and paper-based materials will decline in the coming years.

Electronic materials provide a number of advantages for districts. Most notably, the text can be updated frequently without republishing and repurchasing new materials. Secondly, digital texts can embed a variety of interactive objects that students can use to help visualize concepts. Digital texts can also use links to broader information found on the Internet. This provides an environment where textbooks are one portion of a much larger information world as opposed to a self-contained time-fixed object.

The national landscape includes a variety of statewide initiatives and grassroots groups working to advance the concepts of digital curriculum. Arizona, Utah, Texas, Virginia and Hawaii have facilitated conversions to digital curriculum through various state-support mechanisms. A more grassroots example is the Minnesota Partnership for Collaborative Curriculum, which districts join voluntarily and collaboratively write and consume digital text materials.

Digital Equity

School districts across the nation are involved in conversations about the meaning of the term college, career and life-ready. To this end, many districts are examining the issue of digital equity with the belief that all children would benefit from common understandings both about learning the technology and using the technology to learn.

Mooresville Graded School District in North Carolina, which is often recognized as a model for successful technology implementation, had a significant focus on digital equity. This initiative aligned to several other aspects of the district's strategic plan, which referenced a need for all students to have experiences and all students to be held to high expectations. Several

references can be found in their reports regarding the importance of equity and providing similar access to powerful learning to all.

Personalization of Learning

One particular struggle for school districts is the ability to personalize education for children who may need different experiences or may need to proceed at a different pace. In the book Disrupting Class, by Michael Horn and Clayton Christensen, the plight of school districts is described as a familiar model of batch processing. Batch processing is a system where students are educated in large quantities and moved along regardless of whether they have learned anything. The authors argue that the American public education system was designed to mass manufacture instruction and lacks an ability to significantly personalize the experience. Technology is a promising tool in education, according to the authors, but too many obstacles interfere with successful personalization.

Educators face a significant challenge to truly customize learning experiences. Without adequate tools for student self-directed work, personalization demands a lot of work from an educator and it is difficult at best.

Many research studies produced during 1:1 programs have described teacher attitudes about the ability to change and customize instruction due to increased adoption of technology. Likewise, many studies say that students report increased voice and choice in their work.

21st Century Skills

Many schools across the nation are focusing on 21st Century Skills. Various frameworks have been produced that attempt to clarify these particular skills, but one of the more well recognized frameworks comes from the Partnership for 21st Century Skills. This model divides skills into the broad themes of life and career skills, learning and innovation skills, and information, media and technology skills. This framework is often used to support what is referred to as "The 4 C's": Collaboration, Communication, Creativity and Critical Thinking.

In a review of Michigan's Freedom to Learn Initiative, schools that participated in the program with proper support and fidelity saw an increase in student involvement in projects that involved solving meaningful problems, and teachers were observed shifting to more student-centered practices.

Professional Learning

Today's students are more comfortable with technology than many of their teachers. Providing educators with the tools and resources they need to effectively use technology to increase student achievement is critical.

Maine

Maine's governor had a desire to see the state lead the country in this area, and realized it would require authentic education transformation. In late 1999-2000, the state had a one-time budget surplus enabling it to create the Maine Learning Technology Initiative (MLTI).

Sherry Wyman is the state's School Library/Technology Integration Coordinator. Wyman states that one of the five tenets of the MLTI is teacher preparation and professional development. She said they use several support people from Apple and HP that travel statewide providing professional development. In addition to staff from vendors, the MLTI department is staffed with six full time employees.

Contracted staff assists with providing training sessions on their devices/apps. On the Maine state website, teachers can request staff development from a long list of topics, and depending on the course, it could be a (just in time) recorded session, a one on one session, or they can attend one of the sessions advertised on the MLTI website.

Endowment funding allows the state to staff MLTI with six full time employees who support districts in their goal to deliver technology integration in grades seven-12 throughout the state. In addition, their website contains many resources for districts.

Wyman stated that they are continually evaluating their program. Periodically, to capture (and share) stories of success they interview from district teams that include the superintendent, principal, teachers, media specialist technology support. Here are some examples:

> At the South Portland School District the teacher said that he/she did not need a lot of technology integration help because her students were researching what apps worked best for their learning style.

> Students attend a conference in May to show how electronic tools have helped them develop their passion. Some students have even been able to publish their work.

> If students have a whole year without acceptable use violations, one district allows their students to take their devices home in the summer.

Finally, Wyman stated that equity was a very important concern of the MLTI project and the state libraries provide mobile hotspots to students who can check them out to bring home if they do not have internet access at home either because there was not adequate coverage or if coverage was available but not affordable.

Massachusetts

Five public and private middle schools in Western Massachusetts worked together on the Berkshire Wireless Learning Initiative, an in-depth study over three years to compare differences in schools that were offered teacher staff development for 1:1 integration.

There were several pathways offered for professional development including:

- Certificate and graduate classes.

- Annual conferences.

- In district training, including:

  o Targeted topics.

- o Curriculum integration.

- o Best practices workshops.

- o Apple workshops.

They used surveys, teacher interviews, principal interviews, student drawings and classroom observations to evaluate the schools. Surveys were done prior to the start of staff development and during the three years of the study. The study found that in the 1:1 settings where additional resources were made available for professional development and curricular integration, students tested up to four months ahead in mathematical skills (Silvernail, 2008)

Hawaii

Hawaii's 1:1 Initiative was a four-year plan. Once under way, changes in equipment and available funding required that the device purchase and staff development plan be compressed into just one year. Currently, the state provides two full-time positions dedicated to on-demand, customized support that can be used at each school for one-to-one support.

Arizona

Schools in Northern Arizona collaborated with an E2T2 Grant and were able to provide traveling technology integration coaches. The district provided release times so teachers could do site visits to observe other teachers. Integration coaches visited teachers a minimum of every two weeks to help with lessons and use of technology.

North Carolina

North Carolina had a three-year 1:1 Learning Initiative Pilot. Year two of the initiative focused on changing classroom instruction. To accomplish this they started with a two-day session grouped by content areas. They identified a technology facilitator, which is pretty similar to licensed technology integrationists in Minnesota. This staff person focused on modeling the use of technology and not device troubleshooting or assistance.

Teachers then had access to online classes available on demand. They could be taken all at once, or over a longer period of time. Teachers were also encouraged to forge bonds with their curriculum peers through an online community.

The following needs were identified:

- Different levels of professional development.

- Content specific development.

- Hands-on activities.

- Learning management systems (tools for planning, developing, storing, accessing).

- Time to develop curriculum (lessons, activities, tests, etc.).

- Site visits.

- Instruction on school/copyright, CIPA policy.

- Ongoing support.

Districts took two approaches to identifying the technology facilitator. Some hired a new person to fill this role, and others named a lead teacher to take the role on. The Friday Institute Report stated that five out seven schools participating in the survey had student teach teams in place and they assisted teachers with technology issues.

Recommendations

Districts implementing 1:1 device programs need to establish their own policies on a number of items including device maintenance, transporting devices, integration in instruction and how students are approaching learning, and infrastructure requirements. The district leadership needs to provide resources for short-term and long-term ongoing work. This report provides focuses on several recommendations to improve all 1:1 device programs in Minnesota including state support, infrastructure support, and leadership setting a vision.

Leadership

Often when 1:1 device programs are implemented, an overarching plan is not completed. Due to the competitive nature of education, districts are often making decisions about technology that is missing a larger understanding of instruction. All stakeholders should be involved with setting the plan or vision. In engaging these stakeholders, it is essential that the superintendent, school board, technology director, and principals are aware of the outcomes and are committed to the larger vision. This vision should include pedagogy training, student outcomes and learning goals, materials that strengthen learning, infrastructure needs, and underlying belief statements about the value of technology for learning. Further, the vision must be shared by all school leaders.

Office of Educational Technology

An Educational Technology Office at MDE would allow for increased value, deeper implementation integrity and an agile ability to leverage the promise of technology to accelerate learning. While there are some areas at the state level that include subject matter experts, (Special Education, Standards, Finance, etc.) there is none to support instructional technology. Research shows that how technology is implemented is the single largest factor in its effectiveness so there should be consideration of an office of education technology.

In the past five to ten years, districts' need for technology integration support has increased. Superintendents have been hiring technology specialists to support instruction. Many of the districts have one full-time equivalency for every 2000 students or 100 teachers. When these specialists have looked to the state for support, it has not been available. By creating an Office of Educational Technology, implementation of 1:1 device programs and other technology programs could be better supported.

Infrastructure

Classrooms, schools, districts, and regional school consortia should meet the minimum 2014 SETDA bandwidth and infrastructure targets. This includes areas such as bandwidth to the Internet, connectivity between schools, wired and Wi-Fi sufficient to cover a 1:1 density level of devices. Adequate technical staff and educational technology instructional staffing are essential to plan, deploy, and maintain infrastructure as well as plan for the future.

Funding

A significant and sustainable state investment to support school technology would greatly benefit districts in implementing qualities 1:1 device initiatives. In particular, it would ensure that districts are able to offer students equitable opportunities in the access and use of instructional. Device purchases, device maintenance, infrastructure, and instructional coaching and professional development are all needs identified through both research and survey feedback that funding is needed to sustain equitable and effective programs.

In addition to the funding for schools, the expansion of statewide broadband access will allow students to take their devices home to complete their school work, engage their families in their school work and communicate effectively with their teachers and other students about their assignments.

Bibliography

Argueta, Rodolfo et al. (2009) "Evaluation Report on the Progress of the North Carolina 1: 1 Learning Technology Initiative (Year 2)."

Balanskat, A. (2013) "Overview and Analysis of 1:1 Learning Initiatives in Europe." http://ftp.jrc.es/EURdoc/JRC81903.pdf. Retrieved 7 October 2015.

Broadband - SEPC: State Education Policy Center - SETDA. (2012). http://sepc.setda.org/topic/broadband/state-network/ Retrieved 7 October 2015.

Consortium for School Networking (2011). *Framework of Essential Skills.* http://www.cosn.org/Framework. Retrieved 13 October 2015.

Consortium for School Networking (2014) *The Empowered Superintendent.* http://cosn.org/superintendents. Retrieved 13 October 2015.

EducationSuperHighway. (2009) http://www.educationsuperhighway.org, Retrieved 15 October 2015.

Fox, Christine et al. (2012) "The Broadband Imperative: Recommendations to Address K-12 Education Infrastructure Needs." *State Educational Technology Directors Association.*

Hanover Research Council. (2010, March). The effectiveness of one-to-one laptop initiatives in increasing student achievement. District Administration Practice. Washington, DC: The Hanover Research Council.

Information Booklet - Utah Education Network. (2011). http://www.uen.org/ueninfo/downloads/booklet.pdf, Retrieved 7 October 2015.

ISTE. (2013) Essential Conditions. http://www.iste.org/standards/essential-condition, Retrieved 13 October 2015.

Maine: State Networks - SEPC: State Education Policy Center. (2012) http://sepc.setda.org/state/ME/broadband/state-network/. Retrieved 7 October 2015.

Marzano, R., & Waters, T. (2009). District leadership that works: Striking the right balance. Bloomington, IN: Solution Tree.

Minnesota Department of Education (2015). Minnesota 1:1 Survey.

Minnetonka Public Schools. (2012) iPads Minnetonka Public Schools. http://www.minnetonka.k12.mn.us/ipads. Retrieved 21 October 2015

Mintz, E. (2009). Charting a path from engagement to achievement: A report on the 2009 High School Survey of Student Engagement.

MN E-Rate State Information - E-Rate Central. (2014). http://e-ratecentral.com/us/stateInformation.asp?state=MN. Retrieved 7 October 2015.

Network Essentials for Superintendents. (2014) http://www.educationsuperhighway.org/wp-content/uploads/2014/11/Network-Essentials-For-Superintendents.pdf. Retrieved 12 October 2015.

Shapley, Kelly S et al. (2010) "Evaluating the implementation fidelity of technology immersion and its relationship with student achievement." *The Journal of Technology, Learning and Assessment* 9.4.

State of Nebraska. (2015) http://www.nitc.nebraska.gov/nnag/meetings/documents/Documents/NetworkNebraska_FinancialReport_2011-2014.pdf. Retrieved 7 October 2015.

The White House (2015) *ConnectED.* https://www.whitehouse.gov/issues/education/k-12/connected. Retrieved September 28, 2015.

Tryggestad. (2015) The Role of the Minnesota School Superintendent as a Technology Leader: A Delphi Study. Unpublished.

Universal Service Administrative Company - USAC.org. (2004). http://www.usac.org. Retrieved 7 October 2015.

Utah - SEPC: State Education Policy Center - SETDA. (2012). http://sepc.setda.org/state/UT/broadband/state-network/. Retrieved 7 October 2015.

Walker, Johnson, Silvernail. (2012) *Early Observations of High School Deployment of One-to-One.* https://usm.maine.edu/sites/default/files/cepare/NetbookRpt6_12_Web.pdf. Retrieved 12 October 2015.