Digital Textbook Playbook

The Digital Textbook Collaborative,
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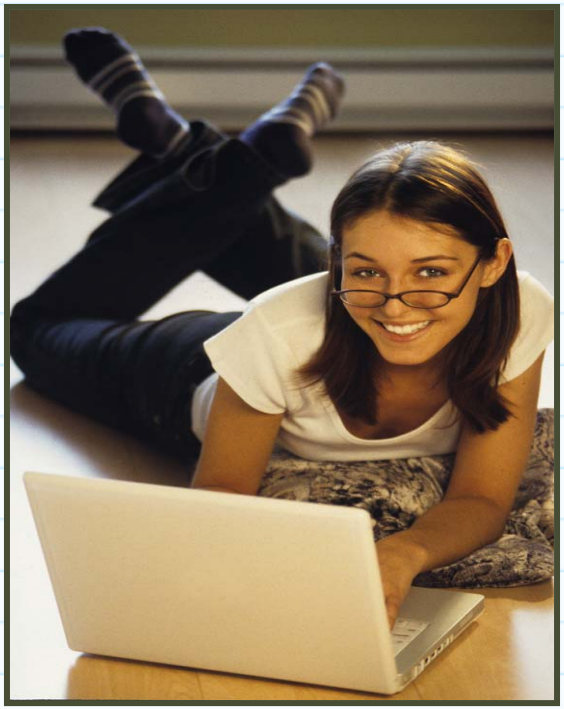


About this Playbook

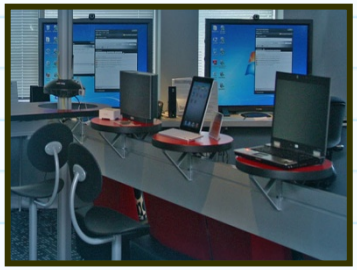
The Digital Textbook Playbook is a guide to help K-12 educators and administrators advance the conversation toward building a rich digital learning experience. This Playbook offers information about determining broadband infrastructure for schools and classrooms, leveraging home and community broadband to extend the digital learning environment, and understanding necessary device considerations. It also provides lessons learned from school districts that engaged in successful transitions to digital learning.

This Playbook is the output of the Digital Textbook Collaborative, a joint effort of industry stakeholders, school nonprofit leaders to encourage collaboration across the ecosystem, accelerate the development of digital textbooks and improve the quality and penetration of digital learning in K-12 public education. The collaborative was convened by the Federal Communications Commission and the U.S. Department of Education and builds upon the FCC's National Broadband Plan and the Department of Education's National Education Technology Plan.

Executive Summary

The Playbook is designed to help K-12 school educators plan for the transition to a rich, interactive, and personalized digital learning environment. The Playbook offers advice and considerations to help schools ensure robust and persistent connectivity to the digital content, understand the perspectives of the variety of device users in a school environment, and plan for the transition to digital learning. This Playbook contains four major guideposts for educators:

Making the transition



Connectivity at school

Connectivity beyond school

Device perspectives

Executive Summary

Making the transition

School districts need dedicated and shared leadership, careful planning, and teacher and community engagement to create a successful digital learning environment.

Connectivity at school

The key to delivering sufficient connectivity is estimating current and future demand at the district, school, and classroom level. This will ensure that schools have enough bandwidth to serve their student body, faculty, and staff.

Connectivity beyond school

To accomplish truly ubiquitous digital learning, students must be able to connect beyond the school walls. This can be achieved through a combination of mobile broadband, community connectivity, and home broadband access.

Device perspectives

A true digital textbook is an interactive set of learning content and tools accessed via a laptop, tablet, or other advanced device. Perspectives of key users should be considered: in particular, students, teachers, and parents.

Introduction

Modern information technology has dramatically improved our ability to work, get health care, stay in touch with family and friends, and inform and entertain ourselves. In only a decade, the Internet has fundamentally transformed the way we live as consumers, as citizens, as patients, and as family members.

However, information technology has been slower to produce meaningful systemic improvements in K-12 education. The dynamic in many classrooms around the country remains decidedly 20th Century: teach the paper textbook, test the students at a fixed point in time, and move on. There also remains a profound disconnect between the learning that happens in school and that which takes place out of school.

Educators are challenged to satisfy the learning needs of today's diversity of students while meeting the increasingly complex definition of what it means to be educated in the 21st Century. Two recent in-depth government analyses, the National Education Technology Plan and the National Broadband Plan, called for leveraging the best of modern technology to transform how teachers teach and how students learn and for improving access and equality of opportunity for learners of all ages.

What are digital textbooks?

In his 2011 State of the Union address, President Obama said, “I want all students to be able to learn from digital textbooks.” The digital textbooks envisioned will come in an ever-evolving variety of technological and instructional variations to meet diverse educational needs and interests. But they will all have in common digital devices with access to rich, interactive, and personalized content that will encompass the primary toolset in digital learning.

No longer will students have to tote 50 pound backpacks with outdated print textbooks. New digital textbooks will be light digital devices – such as a laptop or tablet – that combine Internet connectivity, interactive and personalized content, learning videos and games, and other creative applications to enable collaboration with other students while providing instantaneous feedback to the student and teacher. Digital textbooks can revolutionize teaching and are not simply the digital form of static textbooks.

Making the Transition to Digital Learning

A modern day approach to digital learning is a personalized experience that dynamically identifies and addresses each student's unique learning needs in a manner appropriate to their learning interests, styles, and aptitude, and does so anytime and anywhere. This personalized learning model is made possible by digital learning that leverages persistent connectivity, large-scale data processing, and rapidly advancing device capabilities to individually engage every student.

The following report "The Digital Learning Imperative," by the Alliance for Excellent Education, gives a definition for digital learning and provides an overview of specific benefits of digital learning with an emphasis on instructional strategies. http://fcc.us/wOnONu

Why make the change?

- ***Effectiveness***

There are many indications that leveraging technology can improve the opportunity for educational access, improve student engagement and achievement, and improve learning productivity:

- According to the U.S. Department of Education and recent studies by the National Training and Simulation Association, technology-based instruction can reduce the time students take to reach a learning objective by 30 to 80 percent. According to a meta- analysis and review of online learning studies by the U.S. Department of Education, on average, students in online learning conditions performed better than those receiving face-to-face instruction.
- According to Project RED, a national research and advocacy initiative focused on how technology can revolutionize education, continuous access to a computing device for every student leads to increased academic achievement and financial benefits, especially when technology is properly implemented.
- Online collaboration contributes to improved graduation rates and other academic improvements, according to Project RED.

- ***Student engagement***
  Today's students are "digital natives" – they are growing up in a decidedly digital world. Digital learning educates students using the same technology they use for communication and entertainment outside of school – smartphones, tablets, and laptops. It is not that students are only engaged by technology, but instead the passive, one-size-fits all education practices are not adequately adaptable to each student's needs and aptitude.

- ***Richer, more personalized classroom experiences***
  The digital learning environment has modular lesson plans and content, adapts to individual learning, monitors student performance, and encourages small- and large-scale collaborations among students.

- ***Equity***
  Digital learning can improve the opportunity to learn for ALL students by ensuring access to a full range of tools, resources, content, and courses regardless of zip code or socioeconomic status, as long as the student has access to broadband at home.

- ***Content***

  Digital content includes richly diverse fields of knowledge, supporting opportunities for interaction with materials, resources, and experts beyond the classroom. And digital content is always up-to-date and virtually infinite, supporting a wide variety of interests and topics.

- ***Cost***

  Replacing textbooks, as well as tests and other printed materials with digital content often includes cost-saving expectations. While not all uses of technology improve cost-effectiveness, properly implemented technology can yield tangible savings in printing, transportation, and warehouse costs. These savings are neither immediate nor guaranteed, as establishing a digital learning environment requires significant initial and ongoing investments in planning, bandwidth, equipment acquisition and repairs, software, support, and teacher training. The important long-term question is the return on investment, looking at costs as well as educational opportunities and outcomes.

Costs and savings

Cost management is fundamental to making the successful transition to digital learning. According to Project RED (www.projectred.org), the cost of technology implementations can vary widely. For example, the reported cost for 1:1 implementations range from $250 per student per year to more than $1,000 per student per year, measured on a four-year refresh cycle.

However, cost savings from going digital are estimated at close to $600 per student per year across the following verticals:

- increased teacher attendance,
- reduced copy and paper costs
- using online assessments
- using digital versus print materials
- online learning
- decreased dropout rates

Ingredients of a successful transition

Schools can take different roads to arrive at digital learning. However, it is clear that intensive planning leading to clear goals, teacher training and involvement, collaborative leadership, and commitment to continuous support are essential components for making the transition a success. Leaders and participants who have transitioned to digital learning environments tend to agree on the following issues:

- ***Leadership***
  The most important component of successful digital learning conversions has been strong, collaborative leadership. Some initially successful conversions have failed after their leaders moved on. While individual leadership is important, collaborative leadership provides the opportunity to build a collective vision and commitment that enhances continuity.

- ***Planning***
  Successful implementation of digital learning requires thorough planning. This includes a thoughtful rollout plan created through a collective process with all stakeholders. At a minimum, the plan should address content, infrastructure, maintenance, learning strategies, training requirements, and technical support. It should also be flexible, allowing for course corrections to overcome unanticipated challenges or to seize unanticipated opportunities.

- ***Engagement***
  Teachers are critical to the success of any significant change in education. They should be involved in the planning and rollout of digital learning, and help identify the tools and content, training, and support they will need to fully support their teaching and their students' learning.

- ***Creativity and flexibility***
  Teachers, students, and parents will identify flaws in the plan and can help identify solutions. Leaders and implementers need to listen to stakeholders and work cohesively toward a mutually satisfactory outcome.

- ***Persistence and prioritization***
  Educators and technologists have become infamous for rolling out a new idea or product before the last one has been fully implemented. Successful implementations require focused planning and attention to key implementation factors previously noted. Success takes time and commitment to strategic action plans, review, and adjustment. It often takes several cycles after implementation to determine if a new initiative is working.

- ***Supplant, not supplement***
  Too often technology and digital learning is added on top of the existing practices, challenging already busy curriculums and overwhelming busy teachers. Instead, successful digital learning implementations require modifications to the curriculum to replace ineffective practices with those that best leverage the technology.

Connectivity at School

Robust broadband connectivity is another prerequisite to implementing a rich digital learning environment at any school. The key to delivering sufficient connectivity is estimating current and future demand to ensure that schools have enough bandwidth capacity to serve their student body, faculty, and staff.

As schools consider the various applications that will be used such as Internet research, multimedia streaming, online assessments and interactive digital textbooks, they must keep in mind both the bandwidth that is needed for those specific applications as well as the type of connectivity that is available in the surrounding area.

Forecasting and supplying network bandwidth is an ongoing process and schools should attempt to design their networks in a way that allows for non-disruptive expansion and growth.

Determining bandwidth requirements

Sufficient broadband bandwidth is necessary to ensure adoption, use and effectiveness of digital learning environments. Insufficient broadband bandwidth will interrupt learning and instruction, causing teachers and students to fall back to 20th Century learning methods and abandon new technologies.

- ***Peak demand on a per user basis***

  A school must determine the bandwidth needed to meet the maximum simultaneous (i.e., "peak") demand on a per user basis. This should be regularly monitored so that improvements can be made in a timely way.

  For example, if a school or district is implementing a digital learning platform that relies heavily on video delivered to a student device, the school can approximate the maximum percentage of its students and faculty streaming a video at a given time (e.g. 50%) multiplied by the minimum bandwidth required to stream that content (e.g. 756 kbps, or kilobits, per second). In this example, if a school has 1,000 students and faculty, the maximum bandwidth needed would be 500 mbps (megabits per second) delivered to the school (1,000 x 50% x 756 kbps = 378 mbps).

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Determining bandwidth requirements

The US Department of Education provides educators with a tool to estimate their bandwidth needs. This bandwidth calculator was updated in February, 2012, to coincide with the release of this Playbook. http://fcc.us/wEh7mU

Note: *It is important to check with your content and application providers to make sure the bandwidth estimate from this tool matches your school's chosen content solution.*

- ***School level differentiation***

  Keep in mind that not all schools need the same bandwidth. An easy way to determine a school's bandwidth needs is to base requirements on the projected amount of technology use the school will have and on enrollment figures. Many school districts operate a hub and spoke singular network where all the school's applications and internet access are housed at the district datacenter (the hub). From there, the datacenter connects to each individual school via the WAN (Wide Area Network). Because all of the spoke connections come into the WAN connection at the datacenter, that particular connection must have the highest throughput and schools should look at the oversubscription rate they can tolerate on that datacenter WAN connection.

  Schools can determine the oversubscription rates they can tolerate by analyzing network reports that show average and peak utilization on WAN circuits. The oversubscription rate will influence the end user experience with the application or content.

  Consider a district that is made up of elementary schools with less than 800 students, middle or junior high schools with enrollment between 800 and 1500, and high schools with enrollment greater than 1500. The current WAN bandwidth design for this district would be elementary schools connected to the district WAN at 100 mbps, middle schools connected to district WAN at 500 mbps and high schools connected to the WAN at 1gbps (gigabit = 1000 mb).

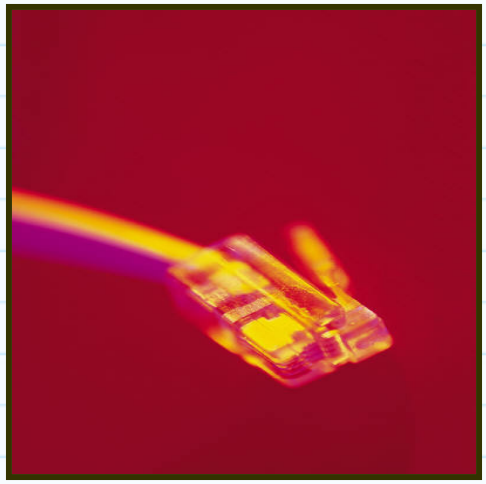
Delivering broadband to the school district or the school

Many school districts purchase a large connection to the Internet from a local Internet Service Provider (ISP) and have a Wide Area Network (WAN) from the district to each school, between schools and to the external Internet. This section discusses network design considerations and cost management techniques that allow educators to successfully deliver broadband connectivity to schools, as well as to the individual classrooms inside.

School districts have various broadband service options from copper wiring to fiber optic connections.

- ***Copper transmission lines***
  Prevalent in communities, copper wires form the basis of traditional communications infrastructure and can now deliver phone, broadband and, in some cases, video service.

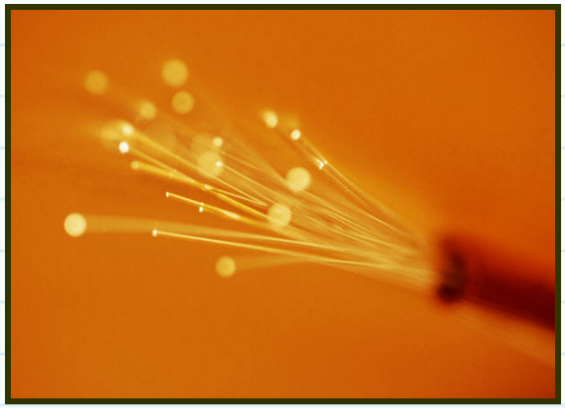
  For example, some rural school districts tend to rely on copper transmission lines because it is unlikely there is sufficient user density in these areas to make installing newer network infrastructure cost effective for service providers. In addition, government supported build-outs of advanced infrastructure may not have reached these communities yet.



Schools' copper wire transmission lines generally deliver the same upload and download transmission speeds of 1.544 mbps. Broadband providers offer options to allow schools to order several DS-1 circuits and aggregate their bandwidth together to create a single, faster circuit.

- ***Fiber optic transmission lines***
  Typically, large, metropolitan school districts and rural areas with new fiber build-outs use fiber optic transmission lines instead of copper wires. Broadband providers in these areas have installed large amounts of fiber along major thoroughfares to serve a variety of customers, including corporations, state and local government agencies, schools, libraries, and cell towers.

  Fiber optics offer faster broadband speeds than copper wires can deliver. Fiber optics circuits, when carrying Ethernet protocol traffic, can provide a school location broadband speeds ranging from 2 mbps up to 10 gbps (gigabits per second).



- ***Host locally or go to the cloud***

  Digital content is commonly transmitted to a student's or faculty member's device over the district's network as opposed to being stored on the device itself. Schools must decide whether to transmit this content from their data center or from “the cloud”. Schools should evaluate which content is best served from the cloud, and which is best served locally.

This article demystifies the differences between the public cloud and the private cloud, also known as a data center.
http://fcc.us/ADIpKL

Each option has its benefits and drawbacks:

- ***Serving from a data center***
  This approach is good for schools intending to serve a large volume of educational content since it allows the district or school to take advantage of its WAN instead of transversing a congested connection on the Internet. Many multimedia-heavy academic applications are now available as a locally hosted or "private cloud" service for this reason. There are costs to consider including paying for the server, power to run the server, and staff time to manage the server. As a result, schools will need to carefully consider which applications should be hosted at the data center.

- ***Storing on the cloud***
  Content providers typically offer schools the option to purchase access to educational content from the cloud for a monthly charge. Benefits of a cloud-based server include little to no capital outlay for the district or school and less internal time and fewer resources to manage the process. However, accessing content from the cloud requires large amounts of Internet bandwidth connectivity. Consider just one video stream delivered across just two classrooms of 30 students. That's 60 x 500 mbps – a temporary burst of 30 mbps on top of all the other internet bandwidth required by that school site at the data center.

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Cloud resources

The following resources provide additional information on the “Cloud” in K-12 education.

The article “Diving Into the Cloud,” serves as a guide to cloud computing for school districts.
http://fcc.us/w9OROB

This article describes the concept of cloud computing in K-12 education, including how to set up the appropriate infrastructure.
http://fcc.us/zPxAeU

More cloud resources

Textbook publishers and other content providers increasingly use the cloud to provide their users with access to their digital textbooks and curricula. For additional information regarding the benefits of cloud-based digital content go to this link.
http://fcc.us/xPptwN

Using the cloud is not a one-size fits all model. Various options exist and educators need to determine which solution best fits their needs. The following article highlights various options available to educators, and details various drawbacks to different solutions.
http://fcc.us/yOxjJs

Securing the network

Complex security threats can lead to negative educational, financial and legal outcomes. By taking advantage of a combination of technologies and trends, however, you can enable teachers to provide quality instruction while working in a safe and secure environment. Network security can be achieved through governance and compliance with IT policies and utilization of specific, complementary software components.

The following article, “Fine-tuning Internet Security,” explains the various needs for providing a school sufficient Internet security. Lakeview Academy in Gainesville, Ga., is offered as an example, and various Internet safety programs are also detailed.

http://fcc.us/A3efpp

Connecting the classroom

Designing the connectivity of classrooms inside the school is equally as important as ensuring the school and school district have sufficient bandwidth capacity.

The bandwidth goal for individual classrooms and other school facilities will inform the overall network design. Schools may want certain classrooms and facilities to have more bandwidth than others.

For example, a school might determine that in an auditorium holding 500 people, each person could potentially have a Wi-Fi connected device, requiring far more bandwidth than a standard classroom. It's also a necessity to build in future capacity needs. While the number of seats in a classroom is not likely to change, it is nearly certain that the bandwidth requirements per seat will increase in the future.

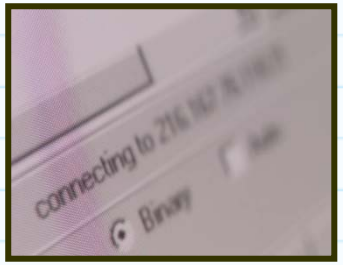
Optimizing bandwidth and reducing cost on school premises

For most educators, cost is the main obstacle to sufficient connectivity. However, the right connectivity strategies can keep costs down. Many experts believe that wireless connectivity within schools using Wi-Fi will be the prominent connection method, especially with the explosion in use of tablets and other portable devices that connect exclusively through Wi-Fi. Wi-Fi can also help keep costs down as compared with the costs of hard wiring all classrooms.

Optimizing Wi-Fi delivery

Adaptive Wi-Fi for improved reliability

Plan for Wi-Fi capacity, not coverage



Maximizing network efficiency

E-rate funding

- ***Optimizing Wi-Fi delivery***
  A network that is optimized for Wi-Fi can cost less to operate than older systems relying on wired Ethernet connections. Using Wi-Fi also reduces wiring costs and the physical space needed to house wiring centers. Finally, less power and cooling are needed as compared to wiring centers, which helps districts shrink both their budget and their carbon footprint.

- ***Use adaptive Wi-Fi to improve reliability***
  Any Wi-Fi deployment must also take channel planning into consideration. Wi-Fi access points use a specific channel of spectrum and many factors can lead to interference or poor capacity. Everything from microwave ovens to neighboring Wi-Fi networks cause Wi-Fi interference. Even heavy use of Wi-Fi by one classroom can lead to poor performance in a neighboring classroom. To mitigate these challenges, schools should look at Wi-Fi solutions that automatically identify interference and make adjustments in real-time to improve performance.

- ***Plan for Wi-Fi capacity, not coverage***
  It is important that schools plan their Wi-Fi network for the bandwidth capacity requirements and not just coverage. Classroom Wi-Fi will require more access points than a simple coverage plan to handle the load of dense connectivity and multimedia-based application use.

- ***Controlling use to maximize network efficiency***
  Many application vendors have begun making enhancements to their software so that applications don't fail completely when distributed over a congested or low bandwidth network. This is being accomplished by using adaptive technologies that automatically reduce the quality of the stream based on bandwidth availability.

  Secondly, bandwidth caps can be put into place for certain devices or user groups. For example, a school may want to prioritize bandwidth for teachers over students or for laptops over smartphones and tablets. More granular access control policies can also be used to restrict access to high bandwidth, non-educational applications or websites.

  Finally, automatic policies can be set to ensure that the network is used as efficiently as possible. For instance, schools should consider limiting bandwidth to websites that do not meet core educational needs.

- ***E-rate funding***
  E-rate funding can be used to discount the costs of broadband telecommunications and Internet services, plus certain internal networking equipment and maintenance, by 20-90 percent.

Connectivity Beyond the School Gates

While schools must be connected in order to create a successful digital learning environment, digital learning cannot only happen at school. To accomplish truly ubiquitous learning, students must be able to connect outside the school walls.

Connectivity on devices such as smartphones, tablets or laptops allows students to view digital learning content for greatly enhanced homework activities, find answers to questions as they arise, and collaborate with peers anywhere and anytime.

The primary means of achieving universal connectivity outside of the school or home is through mobile broadband. Other complementary means of access include community connectivity and home broadband access. In an ideal scenario, schools would be able to provide each student with mobile broadband access. However, this is not a reality for many cash-strapped districts. Two shortcuts to ubiquitous connectivity with significant cost savings to schools are wired community institutions, including libraries, community centers and municipal Wi-Fi and broadband access at home.

This section explores schools' options for extending the digital learning environment beyond the school gates.

Mobile broadband using 3G and 4G mobile services

Schools can provide anytime, anywhere connectivity using 3G and 4G mobile services provided by mobile wireless carriers. There are advantages for schools using these technologies:

- ***Less demand on school networks*** — Mobile broadband services do not rely on the campus network and therefore decrease the demand placed on that network. Mobile Broadband wireless technologies give schools the ability to push expenses to a monthly schedule, as opposed to requiring large, upfront capital expenses required by investing in a robust school or community based network.
- ***Greater range*** — Mobile broadband technologies have ubiquitous coverage in urban and suburban areas, whereas Wi-Fi networks generally only cover a few hundred yards at most.
- ***Availability and upfront cost advantages*** — All major providers offer national 3G coverage and data plans. 4G is a newer technology and is still being rolled out by carriers nationwide. 4G service provides higher speed data access and is well suited for data intensive applications, such as video streaming. 3G is generally sufficient for Internet browsing, audio and text applications.

Examples of schools using mobile broadband technology:

The San Diego Unified School District's Mobile Learning Program provides 3G service to netbooks supplied to all middle school students at 10 schools throughout the district. For additional information on the district's program, see: http://fcc.us/wl1Eyv

Hawaii conducted a one-year pilot program that supplied some middle school students in the state with mobile devices, allowing portable Wi-Fi hotspots. Eighth grade students at Myron B. Thompson Academy received devices that operated on a 3G network. http://fcc.us/y9F8Zv

There are also disadvantages to providing mobile wireless access for students:

- ***Cost*** — Mobile broadband subscriptions are far more costly than provisioning broadband access on school grounds. Mobile broadband subscription costs are the primary factors in more schools not adopting mobile broadband for their students, teachers, and administrators.

- ***Data caps*** — Another limitation with mobile broadband are data caps. Generally, mobile broadband subscriptions are sold with data use limits. These limits are applied either per user or pooled among a population of users. The cost per megabyte for going over data limits can be substantial.

- ***Coverage*** — The ability to access a mobile network can be limited, especially in rural areas. Schools should make sure coverage is provided where the school desires. Coverage maps can be found on the websites of the major mobile providers, but should ideally be verified by testing the coverage prior to purchase

Managing costs and usage of mobile connectivity

A significant challenge to providing mobile broadband is cost, but there are ways schools can make it more affordable without limiting the educational value of mobile devices.

- ***Planning curriculum for mobile connectivity***

  Knowing and understanding the curriculum objectives and what applications will be used to achieve these objectives will better prepare the school district to control data usage over a wireless provider's network and the school's Internet network. For example, are students expected to access data intensive applications, such as videos, while mobile? If so, then a 4G data plan with high data caps may be necessary. If the mobile connectivity will be primarily used to transmit text based content and homework (as opposed to bandwidth intensive video), a smaller data plan on a legacy technology could suffice.

- ***Data management plans***
  Schools can curb costs by working with wireless providers to develop a mobile data management plan for the district. One solution may be data-plan pooling in which a district purchases a set pool of data available to use across all devices, instead of a specific amount of data assigned to each. These plans provide a school or school district a safety net: if one person goes over the plan's data allowance, those who use less bandwidth could offset heavy users. Even with data pooling, it is recommended that schools create alerts when a student is approaching the monthly data limit prior to additional charges potentially being incurred.

- ***Auto-detection***
  Another cost saving measure is using devices and software that can automatically detect and switch to an available Wi-Fi network. By using a student's home, school, or even public Wi-Fi for access, data use can be minimized.

- ***Speed caps***
  A school's wireless provider can implement speed caps to manage costs. Oftentimes districts can get the performance they need on speeds lower than the standard provided by their wireless carrier. By accepting lower speeds, districts should be able to negotiate better rates.

- ***Priority setting***
  Using a priority scheme, a district can ensure that those who need better network performance will always have access to it without having to pay for everyone in their community to have that same level of performance. For example, it is possible to set up a network where a faculty member's device has network priority – and thus better speeds and performance – than a student's.

- ***Content access efficiency***
  Schools can work with their content providers for practices and efficient settings and queuing protocols for content management on the actual device as they attempt to control costs, while balancing both the full support of instructional options and limiting excessive data use unrelated to educational end goals.

- ***Vary downloading amongst the networks***
  Another way to lower costs is for a district to control what networks are used to download educationally relevant, data-heavy content and applications. For example, rather than individual students downloading large PDF files at home on their mobile device, a district should ensure these downloads occur within the local school network where data costs are not as high as they are within mobile plans.

Other Options for mobile connectivity

Wi-Fi networks are also an option for schools to provide connectivity beyond the campus.

Wi-Fi Enabled School Busses

Students spend hundreds of hours each year on busses getting to and from school. Transforming the daily commute into rolling study halls can extend learning beyond classroom walls and the school day. School districts in Florida, Missouri, Arizona and Washington, D.C. are already implementing this technology.

The required equipment for connectivity is simply an affordable Internet router and a monthly service fee, which is not much more than a single mobile broadband connection. However, the bandwidth capacity of this connection likely cannot handle simultaneous network connectivity by a full school bus of students with digital textbooks.

Vail School District in Arizona hopes to provide Wi-Fi routers on all twenty of its high school busses. Many students in the district reside beyond the reach of traditional broadband Internet providers. With more than 1,000 students at two of the schools using school-issued laptops, the district believes that Wi-Fi enabled buses are a practical solution to provide students with access to the Internet. The following two links provide additional information on Wi-Fi enabled buses in Arizona.
http://fcc.us/w86Sne

School-based neighborhood Wi-Fi networks

Schools embedded in neighborhoods could also open their Wi-Fi networks to the community after school hours, improving homes broadband penetration. While Wi-Fi networks generally only extend a few hundred yards, this could potentially cover hundreds of home in a dense urban area.

Schools could install roof based Wi-Fi routers to help extend the range of the network. Schools could also use wireless repeaters to further extend the range of the network, although this generally requires access to poles or other infrastructure. In the near future, so called “Super Wi-Fi” technologies could further extend the range. However, schools should make sure any plans are made pursuant to CIPA rules.

Community connectivity

Broadband access in the community extends the digital learning environment for students without calling on schools' limited resources. Community connectivity is often the only choice for students without broadband at home. Schools can play a major role in building and promoting the use of community locations. However, community connectivity can never be a sufficient replacement for home connectivity.

Community institutions close early, often have an insufficient number of computers and can be located in areas not easily accessible by students at any time of day.

SmartChicago has a project to provide wide-scale upgrades and availability of public computers at more than 150 locations throughout Chicago. Sites include city libraries, community colleges, public housing sites, workforce centers, senior centers, after-school programs, and other community locations.
http://fcc.us/yKrXaJ

The Boston Broadband program provided 627 new computers with job training software and accompanying Internet in community centers, public housing units, and libraries throughout the city.
http://fcc.us/AcUaDP

The Alvarado, Texas, Independent School District partnered with many community sites and private organizations to create and maintain Internet access kiosks throughout the school district boundaries. http://fcc.us/wfGbOn

Creating "School Spots"

The FCC recently modernized its E-rate program to give qualifying schools the option of opening their E-rate funded facilities, such as computer labs, to the community after school hours, on weekends, or at anytime school is not in session. Schools should take advantage of this opportunity, which now enables students, their parents and other family members to use school computer labs after hours so, for example, parents can help students with homework.

Identifying "third places"

Libraries, community centers and small businesses such as coffee shops offer students "third places" (not school or home) for Internet access. Schools can provide students with maps showing safe local "third places" that offer high speed connections and work with community institutions to extend hours and Internet access.

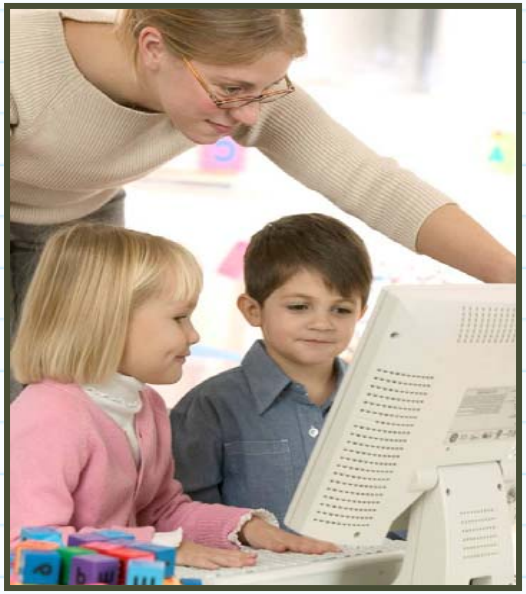
Providing additional resources

Schools can provide additional resources and expertise to transform community institutions into digital learning centers. Opportunities for schools include working with libraries or learning centers to increase off-campus access to online school resources; partnering with community institutions to develop laptop or home computer loan programs; negotiating special Internet pricing with local ISPs for low-income families; and obtaining ISP scholarships for low-income students.

Supporting after school programs

Libraries, learning centers, YMCAs, religious organizations and Boys and Girls Clubs often provide additional resources and connectivity for students to receive academic support. After-school programs are typically funded by government grants and charitable donations from corporations, and are offered to families at low- or no-cost.

Home Broadband adoption



The presence of a home-based broadband Internet connection is an essential ingredient in any rich digital learning environment. Home broadband enables students to use the connectivity on their digital learning devices and complete Internet-based homework from the convenience of their home. Schools cannot sit on the sidelines when it comes to home broadband adoption. A recent Federal Reserve study found that similarly situated students with home broadband and a PC had six to eight percent higher graduation rates than those without a home broadband connection.

Home broadband adoption rates vary by community, and in many low-income areas the home adoption rate is below 50 percent. Home broadband is a key ingredient for ubiquitous connectivity. Instead of providing mobile wireless broadband subscriptions to the entire student body, schools could supply students with Wi-Fi enabled devices that can access students' home broadband connections.

Increasing home broadband adoption

Research has shown that the main barriers to adoption are: cost of the home broadband service per device; digital literacy; and "relevancy" – or the value proposition of broadband.

Schools can address the main barriers to adoption by offering communal digital literacy classes, encouraging parents to purchase home broadband and working with community groups and private companies to develop low-cost broadband and PC offerings for low-income families.

Educators can also encourage home broadband adoption by spreading the word about programs that offer discounted Internet service and hardware to families who do not currently have broadband service at home. There are three programs widely available to low-income and/or free school lunch eligible families.

Home broadband adoption programs

- **Comcast** currently offers $9.95 broadband, an optional $150 netbook, and digital literacy training for students qualifying for the National School Lunch Program's free lunches across its entire service territory. http://www.internetessentials.com/
- "**Connect to Compete**" will offer $9.95 broadband in parts of all 50 states starting in the fall of 2012. This offering will be available to all families who qualify for the National School Lunch Program's free lunches and also will include an optional $150 laptop or desktop and free digital literacy training. http://www.connect2compete.org
- **Century Link's** Internet Basics program will offer $9.95 broadband in its entire service territory (plus activation and modem fees). This offering is available to all Americans who would normally qualify for the FCC's Lifeline program. This program also offers free digital literacy training and an optional $150 netbook for families that agree to a two-year service agreement. http://www.centurylink.com/home/internetbasics

Device Perspectives

Devices provide the window to any personalized digital learning environment. Many schools opt to provide devices for each student, whereas other schools adopt a BYOD (bring your own device) model. The device marketplace is developing rapidly, especially as tablets are becoming a viable option for many schools.

The power of advanced devices, combined with the data, connectivity and interactivity of a personalized learning environment, allows educators to:

- Access more resources and data to increase effectiveness, efficiency, and relevancy
- Provide a personalized learning experience in which data on what students are learning and how they are learning can be assessed at an individual level
- Remove barriers between student data, curriculum map, and learning outcomes
- Allow students to become experts and contribute to their learning materials by responding to them in real time and adding to the pool of knowledge (i.e., Wikis, blogs and interactive video textbooks)
- Redefine learning materials as interactive video, text, or voice media
- Push students to the highest levels of thinking: evaluation, analysis, and creation

Choosing a device

This section provides important perspectives from each group of stakeholders at a school: the students, the teachers and the parents.

When choosing a device, schools must be sure to take into account the use cases of the entire school community. To make the potential of an advanced device more tangible, picture the following capabilities from a student, parent and educator perspective.

- ***Portability***

  Students can learn anytime, anywhere. The device is connected to a network and is lighter than a pile of books. Likewise, teachers can plan and facilitate learning from any location. They can work outside the school, and still easily access work back in the classroom. Additionally, parents appreciate that even when their child is away from school, the child still has the ability to learn with the benefit of rich digital resources.

- ***Interactivity***
  Students can share ideas, concepts or work and receive immediate feedback via real-time communication in text, voice or video. Teachers are able to quickly and easily access student work, assess it and gain insight into student progress. Plus, they can give immediate feedback on ideas, concepts or work that students have done, in a confidential manner. Parents can get an immediate view and feedback on their child's ideas, concepts or work. It increases the opportunity and makes it easier for parents to be consistently engaged in their kids' learning due to the ability to communicate with a child's teacher.

- ***Collaboration***
  Students can work together in real time remotely and locally with peers to share, solve, author and create class content. Similarly, educators can work together in real time remotely and locally with colleagues to plan, author and share best practices.

- ***Durability***
  The device can travel in a teacher or student bag and get to school, home and back without breaking due to its durability or protective casing. Parents are at ease knowing they don't have to worry that the device will easily break.

- ***Connectivity***
  Students and teachers alike can connect when they need to, which extends learning time. And, parents can see what their child is doing at any time without interrupting the learning process.

- ***Capacity***
  Students and teachers can also use the device all day long without interruption. They can upload, store, transfer, share and access whatever is needed, whenever it is needed. Students can store content and go back to it later. Allowing a student to consume the information and then review it later establishes a better chance of retention and understanding.

- ***Differentiation***
  Students can learn in whatever way that best suits their particular learning style. They can read digital text, access multimedia, engage with instructional software and learning apps, and synthesize and communicate in multiple mediums.

- ***Accessibility***
  Every student can use the device and technologies. The embedded tools allow for a more personalized and less one size fits all learning environment. Teachers can easily adapt and incorporate accessibility features in the device(s) to facilitate and differentiate learning for students at all level of ability, including those with special needs.

- ***Immersive reading***
  Users can comfortably read for long periods of time. Devices provide sufficient lighting, choice of font size, and text-to-speech for accessibility.

- ***Multilingual***
  Students can learn in multiple languages and change devices to suit individual language needs. Parents and educators can use the technology as needed to communicate with one another. Teachers are also able to communicate with colleagues and administrators.

- ***Multimedia***
  All users can create, consume, modify and share content in a variety of forms, including video, audio, images, and text. They can also capture inputs of the same media, including authoring and composing of video, audio, text, and images.

- ***Extensibility (data & device)***
  The devices interoperate with other devices and technologies, reducing barriers within the learning environment and at home.

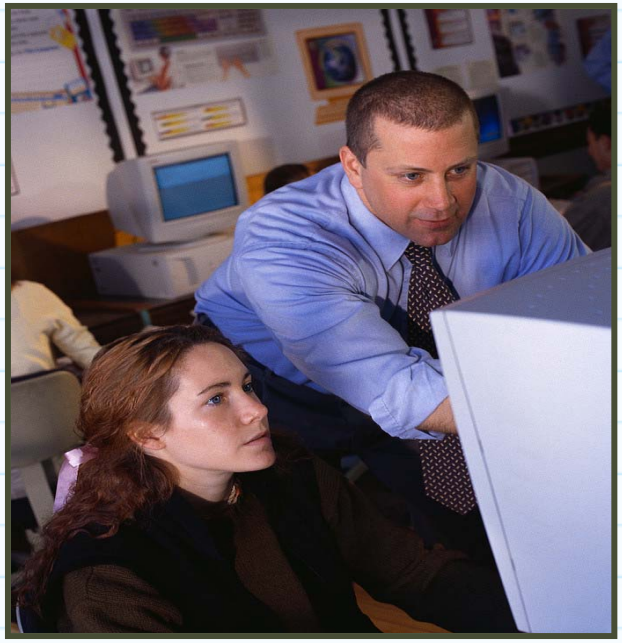
- ***Multi-input***
  Students and teachers can enter information and capture ideas using multiple input devices, such as stylus, finger, voice, image, mouse, camera, switch, or microphone.

- ***Multidimensional***
  The digital world and the physical world are bridged through synced digital learning experiences. For example, in a frog dissection, or studying the movement in space, measures, gestures, and simulation-based video connect the virtual and physical to create multidimensional outputs.

The educator's device also has significant impact on the educator's professional development. Picture an educator who also has this to say about his or her professional development:

- ***Interactivity***
  I can receive immediate feedback on ideas, concepts or work, such as real-time communication in text, voice or video. I can collaborate with other educators and peers from around the world, both in formal and informal learning settings. I can connect with experts in the field in any area of study to give me background knowledge and real world information for my students.

- ***Capacity***
  I can capture and store professional development information to use when I have the time to spend and have the ability to go back to the information for better understanding.



School-provided device

Most schools that implement 1:1 digital textbook learning programs provide a standardized device for all students. Many schools start with a cost analysis for such a digital learning program and then proceed to evaluate the various device types and options within each device category.

Schools should keep the different device perspectives, covered in the previous section, in mind when determining a device pathway.

School-provided devices range from smartphones to laptops, tablet, and netbooks. The following article details various 1:1 learning programs and the devices schools have chosen to supply. http://fcc.us/w2hqbt

It is important to consider some pros and cons of a school-provided device model:

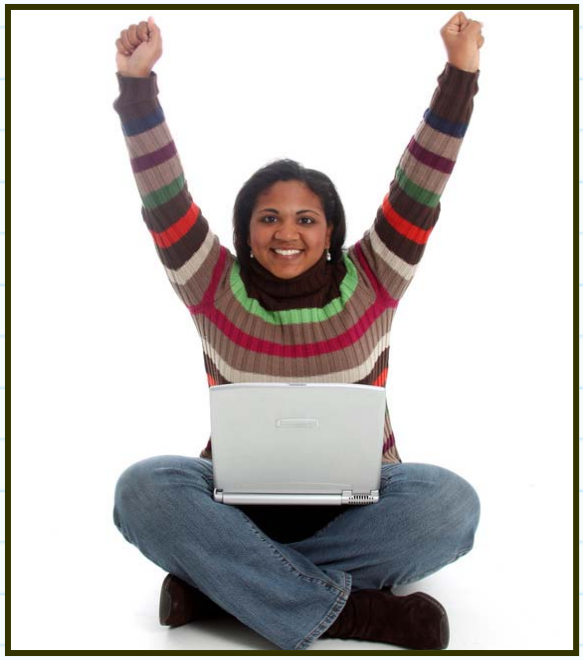
Pros:

- ***Security and control***
  Schools can have more control over device capabilities, functions and security settings.

- ***Compatibility***
  Uniform devices chosen by a school guarantee compatibility with content and programs.

- ***Device costs***
  Volume purchasing by a school could provide a discount over retail sales to students and families.

- ***Equity***
  All students have the same device which limits device "envy" and does not burden low-income families.



Cons:

- ***Cost***
  Schools would have to bear the cost of purchasing a device for every student, even though most students may already have a compatible device.

- ***Lack of choice***
  School-provided device scenarios may not allow students and families to choose the technology that suits them best.

Bring your own device (BYOD)

A number of schools have found success in implementing a BYOD model, which allows students to bring and use their devices for digital learning. BYOD requires planning and curriculum development, plus standards to implement a program that is successful.

For example, a school should set capability standards for any device that students bring to school to make sure it is compatible with the school's digital learning platform.

Schools that implement BYOD should also consider having loaner devices available for students that may not be able to afford a device.

Students in select classes at South Forsyth High School in Georgia are permitted to bring their own technology to school. The school provides explicit instructions regarding the program, the Internet connectivity and the security, and requires students to sign an agreement to participate.
http://fcc.us/wrPdWz

The West Chester Area School District in West Chester, Pa., also began a BYOD program after experiencing positive outcomes with a netbook pilot program.
http://fcc.us/yDA33x.

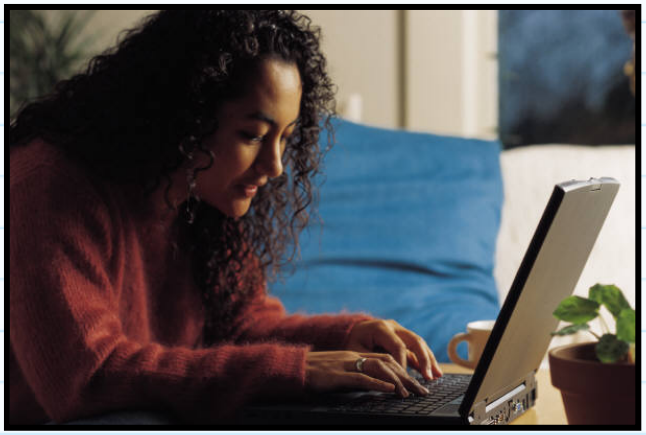
It is important to consider some pros and cons of a BYOD model:

Pros:

- ***Choice***
  Allows students and families to choose the best device for them.

- ***Ownership benefits***
  Students who have an ownership interest in a device may take better care of the device as opposed to a school issued device.

- ***Cost to the school***
  Significantly reduces the school's upfront cost of providing technology.



Cons:

- **Digital divide**
  Low-income families may not be able to purchase needed devices. Schools must be prepared to give or loan devices and network plans for those who cannot afford to bring their own.

- **Incompatibility**
  Having a variety of devices could cause them to be incompatible with the school's chosen operating platform, content, and even connectivity systems.

- **Loss of control**
  Schools will have less control over how students use the devices, including what programs they install on them..

- **Less security**
  It is more difficult for schools to secure a variety of devices.

Other important BYOD considerations

- **Setting minimum requirements**
  Initially, the school district must standardize the minimum requirements for the device. This is entirely driven by the curriculum and how the school plans to use these devices for learning. It is very important to have security software implemented on both school and student-owned devices to prevent unauthorized access to student information and other important school data.

- ***Educating parents***
  BYOD can be successful, but parents must appreciate exactly why and how these devices will be used. It is important to set expectations, demonstrate capabilities, and engage parents in seminars and training.

  Although many schools have parents sign agreements of responsibility for misuse of the device, the final responsibility lies with the school district for the safety of its students while in school.

Parental buy-in is an important aspect of a BYOD program. The following article discusses the experience of a school district in Ohio in gathering parental support, as well as other aspects of a bring your own device program.
http://fcc.us/ADNsvB

Additional considerations

Beyond the experiences detailed, there are significant additional considerations before moving into digital learning environments. While not covered here, these issues should be addressed in the context of a school's device decision-making path.

- Procuring and managing content
- Learning management platforms
- Teacher and administrator training
- Technology assistance and support
- Security and privacy controls
- Data systems and integration
- Device and content interoperability

Leaders in the Field

Many districts, schools and states have transitioned from traditional paper textbooks to digital learning environments. Some programs have attempted to develop platforms and identify content individually and others have adapted available platforms to fit their needs. This section provides examples of pilot programs and full-scale implementations that have occurred around the country.

Schools and districts

- **Mooresville, N.C.,** began providing laptops to every student and teacher in grades 4-12 in 2009, making it one of the few entirely digital districts in the United States. In total, over 5,000 laptops have been distributed. By replacing textbooks with laptops, the superintendent believes the district has developed a successful financial model, and a solution to the "disconnect" between students' daily digital lives and the previous lack of in-class technology. http://fcc.us/zXV3S7

- **Forsyth County, Georgia's iAchieve Virtual Academy** offers students the opportunity to engage in a digital learning environment to achieve their individual potential through innovative, flexible, socially connected and student-focused education. iAchieve is open for students in grades 6-12 who are residents of Forsyth County entering the school system for the first time. http://fcc.us/xQrz4W

-**Onslow County, N.C.,** schools face the increasing challenge of students falling behind in their studies and losing sight of developing core competencies. The primary focus of Onslow County Public Schools is to build students' knowledge and give them the technical skills that will lead to graduation and place them on a path to success. Project K-Nect piloted with students' smartphones and applications to share content, complete assignments, collaborate inside and outside the classroom, take quizzes and improve language skills. http://fcc.us/xjixMo

-**The San Diego Unified school district** in California embarked on a five-year journey to transform its classrooms and completely revamp the way San Diego students learn. Since that time, the i21 Interactive Classroom Initiative (i21) has expanded into more than 3,500 classrooms and has distributed some 78,000 netbooks and other mobile devices to teachers and students. Educators also established a Mobile Learning Program to seamlessly integrate ubiquitous, one-to-one computing and other 21st century technology into teaching and learning throughout the curriculum for sixth-grade classes in eight middle schools and school-wide in two middle schools.
http://fcc.us/zu3AZW

- **Auburn City Schools, Auburn, Ala.**, established a 21st Century Learning Initiative that has transformed the entire school system. They developed and support a 10-year vision, with aligned budget, for creating a one-to-one learning environment, using robust digital tools tied to curriculum/student outcomes. The district has incorporated a strong leadership development component to ensure capacity, scale and sustainability for the transformation. They engage a rigorous evaluation process for each component.
http://fcc.us/wxbBlq

- **East Orange, N.J. High School** formed a partnership with Verizon Wireless to provide 480 students in the senior class with tablets to replace their textbooks after completing a smaller-scale pilot program the year before. The tablets come equipped with security features to ensure their main use is for educational purposes. The ultimate goal is to add one class per year to the program, eventually placing a tablet in the hands of every student. http://fcc.us/yHraSU

'Blended' charters:

- **Carpe Diem** is a hybrid model school, rotating kids between self-paced instruction on the computer and traditional classroom instruction. The school building is laid out with one large computer lab, with classroom space in the back. Carpe Diem has successfully substituted technology for labor. With seven grade levels and 240 students, the school has only one math teacher and one aide who focuses on math, covering 240 students in grades 6-12 and getting the best results with a demographically challenging student body.
http://fcc.us/wGX02g

-**Rocketship** opened the first U.S. hybrid school in August 2007. Rocketship's innovative Hybrid School Model combines traditional classroom teaching with individualized instruction using tutors and online technology to meet the specific needs of each and every student. Rocketship uses two forms of digital learning: online instruction in Learning Lab and in a Response to Intervention (RTI) program that offers tutor-led, small-group interventions for the lowest-performing quartile of students.
http://fcc.us/whKv39

States:

- **West Virginia** has implemented a suggested two-year suspension on social studies textbook purchases, and plans to invest the savings in digital textbooks and technology infrastructures.
http://fcc.us/z4pTrG

- The **Texas** legislature recently created an Instructional Materials Allotment (IMA). Districts can use these funds to purchase electronic learning platforms and content from online resources, and to cover other technology-related expenditures. School districts are able to receive an allotment per each student enrolled in the district by a specified date preceding the start of a school year. The allotment per student may vary based upon the amount available in the IMA.
http://fcc.us/yYvIs7

- **Florida** is the first state to mandate adoption of digital learning tools in all public schools. Beginning in the 2015-2016 school year, all instructional materials in grades K-12 in the public school system are required to be provided in electronic or digital format. Florida is not requiring a specific brand or form of digital textbook, nor is it requiring distribution of devices or other supplies.
http://fcc.us/ykFj8a

- **Virginia** plans to provide resources and support to ensure that every student has access to a personal computing device and to deliver appropriate and challenging curricula through face-to-face, blended and virtual learning environments by 2015.
http://fcc.us/zCuU1U
http://fcc.us/zNE8K0

- **California** has launched a free digital textbooks initiative in 2009 that includes free texts for California students in grades 9-12 in geometry, Algebra II, trigonometry, calculus, physics, chemistry, biology/life sciences, and earth sciences, including the investigation and experimentation strand.
http://fcc.us/xj3Z4I

- **Maine** launched the Maine Learning Technology Initiative (MLTI), which adopted a One-to-One laptop initiative for all middle school students in public schools in 2002. The program distributed more than 30,000 computers to seventh- and eighth-grade students throughout the state. The program has expanded its reach to high school students by providing wireless network infrastructure to schools to aid in supporting laptops, as well as offering discounted laptops. The results of that effort have been extensively reviewed in a series of research papers.
http://fcc.us/wIOd8U
http://fcc.us/xsDJnL

Contributors

We thank the following participants for their part in the creation of this document:

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