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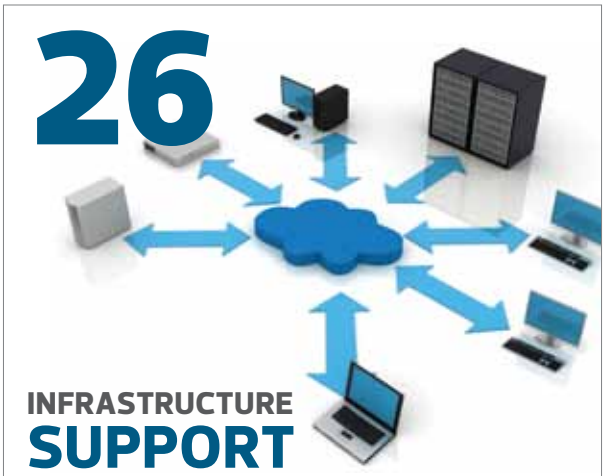

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Technology in the Classroom

Harnessing technology to enhance teaching and learning and improve student outcomes and graduation rates

Technology has clearly transformed the way students relate to the world around them. Today, their lives are centered around a web of electronic connections to other people and to information.

Adults marvel at the facility with which the young master new technologies and become immersed in them. But these digital natives, who have never known a time without the Internet or smartphones, are simply doing what comes naturally, embracing the changes that technology is bringing to almost all aspects of modern life, especially the workplace.

Educators now recognize that it's not enough to teach students about technology — they have to use it as part of the learning process. Integrated into the classroom, technology can revolutionize education, creating a student-centered model that encourages both collaboration and creative thinking.

While there is much to aspire to, today's budget constraints find school districts facing an immense challenge: How do teachers, administrators and IT staffs juggle keeping up with the explosive pace of technological advances and the reality that IT projects tend to move slowly at most districts?

And there's the continuous problem of how to pay for it. The budget numbers tell the story: The 2011 CDW•G *21st Century Classroom Report* found that 47 percent of school IT professionals saw their budgets decrease for the 2011–2012 school year, while another 25 percent saw no budget increase (*See Budget Challenges sidebar*).

The good news: Despite funding constraints, 65 percent of IT professionals report that their districts are planning to upgrade or improve classroom technology in the next two years, up from 51 percent in 2010.

Improving Teaching and Learning

One of the most dramatic benefits of classroom technology is that it inspires students to learn. Today's students find it perfectly natural to learn using digital audio and visual content, resources that are generally more up to date than the print textbooks they augment or replace.

While those surveyed for the CDW•G report cited cost (65 percent), faculty preference for print (53 percent), and faculty reluctance to switch media (44 percent) as barriers to digital content

BUDGET CHALLENGES

Lack of budget was identified as the biggest challenge to classroom technology integration across survey groups.

43% IT staff
37% Faculty
34% Students

Source: 2011 CDW•G *21st Century Classroom Report*

adoption, 39 percent of districts support digital content and 73 percent of faculty consider those resources essential for the modern classroom. So despite numerous concerns, there is strong support for technology in the classroom — and with good reason.

Student response systems make participation easy and fun. Interactive whiteboards change static presentations into dynamic interactions, allowing the teacher to develop digital material in real time with student input. It's little wonder that the report indicates 79 percent of faculty considered interactive whiteboards a must-have tool and 69 percent of districts support the technology.

Digital tools and content facilitate enhanced communications, both among students and between students and teachers, by opening new ways to share ideas and resources (*See Enhanced Communication sidebar*). The CDW•G report also indicates that students understand the stakes involved in their learning with and about technology. Ninety-four percent believe that learning and mastering technology skills will improve their education and career opportunities.

While preparing students for the changing workplace may be sufficient reason to integrate technology into the classroom, the implications of that integration go much further. They also engender a more sophisticated and responsible approach to media and tech tools among students. They learn to negotiate the burgeoning technology landscape with improved judgment and a better chance of becoming good digital citizens.

ENHANCED COMMUNICATION

CDW•G research has found that a majority of students use technology to communicate with other students, but may need assistance in developing collaborative skills.

59% **Communicate with other students for learning purposes**

23% **Collaborate with other students**

Source: 2011 CDW•G *21st Century Classroom Report*

Technology Trends

Accustomed to ubiquitous access to technology outside of school, students have high expectations for tools, digital content and connectivity in the classroom. But just 39 percent of the high school students surveyed for the CDW•G report say their school currently meets those technology expectations.

A communication gulf also exists between students and school officials, as only 30 percent of the students responding to the survey say their high school seeks student input on classroom technology.

Further, while 74 percent of faculty and 70 percent of school professionals say they understand how students want to use technology as a learning tool, only 49 percent of high school students agree. The push by students and their parents to narrow those gaps will lead to increased adoption and more creative use of classroom technology.

Student expectations are paralleled by teachers' expanding lists of the technologies they want in their classrooms. The must-have technologies among faculty are wireless connectivity (85 percent), personal computers (84 percent), interactive whiteboards (79 percent) and digital content (73 percent). But there are other desired technologies, ranging from off-campus network access to student response systems (*See Beyond the Must-have Technologies sidebar).*

Change is already in motion. The 2011 CDW•G report indicates that IT professionals say support for key technologies has increased substantially over the past year. The number of districts that support digital content has jumped from 29 percent a year ago to 39 percent; support for course management systems is up from 30 percent to 42 percent; and student response systems are now supported in 44 percent of districts, compared with 35 percent last year.

The increased emphasis on science, technology, engineering and math (STEM) curricula in many schools also helps promote the expanded use of technology in schools. Learning management systems and online content that can be accessed on demand for study and review can be particularly helpful for subject areas resting on large bodies of factual information. Schools also recognize the synergy in teaching and learning technical subjects using technology.

And another trend, the pervasiveness of social media and online communications, is impossible to ignore, but sometimes difficult to harness for learning. File sharing, blogs, chat and online conferencing are perfect vehicles for collaboration. Facebook groups can be at the heart of a personal learning network, but these technologies can also raise thorny issues around acceptable use and digital rights.

Two additional technology trends, "bring your own device" (BYOD) programs and the movement toward blended and virtual learning environments, warrant greater consideration because of their widespread adoption and their impact on the classroom.

BEYOND THE MUST-HAVE TECHNOLOGIES

Along with wireless networks, personal computers, interactive whiteboards and digital content, the majority of faculty consider these technologies important as well.

60% Off-campus network access
59% Virtual learning
55% Multimedia content streaming
54% Course management systems
52% Video and web conferencing
52% Student response systems

Source: 2011 CDW•G *21st Century Classroom Report*

Bring Your Own Device

The BYOD trend was inevitable, a matter of teachers and administrators now acknowledging the futility of enforcing bans on the cell phones, smartphones and mobile devices students own today.

Many districts are starting slowly, designating BYOD days or specific classes in which it's permissible for students to use their own devices. Other schools have recognized the mobile devices as resources, and understand that incorporating them into classroom activities can bring significant benefits.

According to the CDW•G report, 86 percent of students say they use more technology outside of school than in their classes. By bringing the devices students use to connect with their friends and the world outside into the classroom, BYOD bridges a gap between school and the rest of a student's life.

Students discover that the same devices they use to access Facebook, text a friend or play a game can be powerful learning tools.

The feedback loop continues outside of school, when students can use their own technology to collaborate on projects and participate in academic discussions. The result is a more mature, creative relationship with technology and progress toward building good digital citizenship, say educators backing BYOD policies.

Of course, BYOD programs raise some complicated issues for school leaders. A major concern is equal access to technology, an issue that held back many administrators from supporting BYOD. Districts must provide equivalent tools for students who don't have devices themselves. Ideally, those students should also get the take-home access enjoyed by their peers.

BYOD advocates point out that the programs reduce competition for school technology resources, providing more access to students who don't own their own. Some districts, for example, extend one-to-one computing programs to additional classes and grades by allowing students who prefer to use their own devices to do so. This lets the district furnish devices to more students who don't have them.

Professional development around BYOD is another concern. Teachers who have to create lesson plans and learning goals within the diverse technology environment created by BYOD programs are likely to require additional training, as might also be the case for the IT staff charged with supporting the various devices.

The success of BYOD programs also rests on setting effective policies to govern the responsible use of all the devices in the classroom, both those owned by students and those provided by the school. Experience has afforded a variety of best practices for developing those policies:

- **Solicit student input.** Encourage student participation in setting and enforcing policies, as well as choosing appropriate penalties for policy breaches.
- **Don't make policies too restrictive.** The goal is to teach students to

make good decisions on their own. Deploying filtering software on the district network can block inappropriate Internet content at school, but the point is for students to learn how to make responsible choices.

- **Spell out the technical issues.** Some topics schools should address include network access control protocols, device and application compatibility, levels of technical support available and security updates.
- **Set consequences for ignoring policies and follow through.** Without enforcement that includes real but not unreasonable penalties, policies lose their impact and teachers and administrators risk losing control of the BYOD program.

From an IT perspective, BYOD programs can save money on hardware, savings that might be used for wireless network upgrades and security technology. New and somewhat unpredictable bandwidth and coverage demands may require additional wireless access points and network management tools. Network access control systems must be expanded to include student-owned devices, and IT managers should consider whether they need to take extra precautions against viruses and intrusions.

Blended and Virtual Learning

Online learning is here to stay. Thirty-two percent of school IT professionals surveyed by CDW•G report that their districts support virtual learning. Among those who do, 41 percent of IT professionals indicate that their districts support video and web conferencing, and 18 percent say they can record class lectures — two capabilities that are essential to online learning models.

Both self-directed virtual learning and blended courses that combine online independent learning with face-to-face (or at least real-time) interaction with an instructor are becoming increasingly common and popular offerings in K–12 schools.

The *Speak UP 2010 National Findings* report from Project Tomorrow indicated that 30 percent of high school students and 19 percent of middle school students were taking classes online. Blended learning environments are gaining traction at an even more rapid pace, as the asynchronous use of digital and online components is becoming more prevalent.

Efficiency and flexibility are among the most obvious advantages of both virtual learning and the virtual component of a blended environment. Purely online courses can reach many more students than a teacher in a single classroom. Some districts offer the same virtual course to several schools, saving money and resources, and often sharing the expertise of a particularly skilled teacher with a wider audience.

AN ONLINE LEARNING GUIDE

Here are some quick tips for starting an online learning program at your district:

- **Select core technologies carefully.** Choose tools, such as learning management systems, that fit the school or district's specific needs.
- **Offer training.** Make sure both teachers and students have the skills they need to focus on classroom learning rather than on learning the technology. Teachers especially will need training on how to create lessons that take advantage of online learning.
- **Take frequent reality checks.** Track students' progress and pace as they work through online learning courses and components to ensure that they are using their time wisely.
- **Build a robust help desk.** Independent learning can be isolating if students can't reach out for help. Therefore, have both teachers and help desk staff available for academic and technical questions. The site should be constantly updated so students can solve problems on their own if a person is not available to answer their questions.
- **Track the program's progress.** Develop assessment tools, carefully evaluating virtual and blended programs and offerings, including comparing student outcomes with those in traditional classes.

Virtual and blended environments give students more control over their own learning; they can go at their own pace, moving on when they have mastered material or lingering over concepts they find difficult. Courses and individual lessons can also be tailored to individual students to a much greater extent in virtual and blended environments than is possible in traditional classrooms. Independence, increased control and personalization all lead to increased student engagement.

Teachers report that virtual and blended environments put more tools at their disposal, supporting their creativity as they design courses. Both teachers and students have greater flexibility in scheduling. Time previously spent on review sessions or virtual courses or components can be devoted to enriching the curriculum or helping individual students.

Well-designed virtual and blended learning environments incorporate multiple communications channels between teachers and students and among students. Students can collaborate to solve problems, or individuals can more easily reach out for extra help with fewer inhibitions than they might have in front of 25 of their peers. ■

Tools for the Classroom

An inventory of the technology needed to meet the needs of today's students and teachers

Integrating technology into the classroom requires educators and IT managers to work together in choosing tools that meet educational goals. Because few districts can afford to install high-tech classrooms all at once, short-term initiatives are typically the building blocks of a long-term technology strategy. This kind of strategic outlook has to include the continuing development of learning frameworks and the future integration of new technologies.

Personal Computing Hardware

Here's an overview of essential computing hardware for the classroom, some of the benefits they offer and issues to consider when your district makes buying decisions.

Wireless access points: Wireless APs enable the flexibility and convenience of mobile computing. An AP delivers a connection to the school or district's Wi-Fi wireless network. Careful positioning of APs helps districts maximize available bandwidth and coverage.

Desktop computers: Even with the push to mobile computing, desktop computers are still an essential component of most districts' technology strategies. Desktops are deployed at workstations in classrooms, school libraries and computer labs.

Until recently, a desktop workstation consisted of a metal or plastic box containing the CPU and hard drive, along with a separate display, keyboard, mouse and CD/DVD drive. Today, all-in-one units are also available.

A desktop often offers more processing power and memory at a lower cost than a mobile PC. Another advantage is that the separate pieces of a desktop workstation can be customized; users can choose among displays of various sizes, as well as different types of keyboards and mice.

Notebook computers: These devices carry the processing power and memory of desktops in a single, portable unit. Most have built-in displays, a keyboard and a touchpad or rollerball cursor control. They are powered either by rechargeable batteries or an AC outlet.

Similar to desktops, most notebooks have CD/DVD drives and can be equipped with graphics cards that optimize the devices for multimedia content. Notebooks can vary widely in size and weight, as well as in computing power. Today, almost all notebooks have wireless radios that provide access to the Internet.

Netbooks: Many school districts deploy inexpensive netbooks for one-to-one programs and other initiatives aimed at getting technology into the hands of as many students as possible.

As their name suggests, netbooks are small, lightweight notebooks designed as a highly mobile way to access the Internet and perform basic computing tasks, such as word processing and document management. With most models weighing just under 3 pounds, netbooks are convenient and portable, and their low cost lightens the load on school budgets as well.

Tablets: Slate computers, or tablets, are small, handheld wireless devices.

The dimensions of any tablet are never much greater than that of its display, usually 7 to 10 inches. User input is through a touch screen using a finger or, occasionally, a stylus. Some tablets rely on Wi-Fi hotspots for Internet access, while others offer cellular connectivity from a telecommunications provider.

Tablets have limited computing power, and their lack of a keyboard makes the devices a bad fit for some basic functions, such as word processing. The devices shine as portable media players, and their popularity has resulted in the availability of tens of thousands of applications designed or modified for the platform.

The newest tablets shouldn't be confused with tablet PCs, which are fully configured notebook computers with the added feature of a pivoting display that can be used as a touch screen for user input.

E-readers: Students and teachers can now purchase and download electronic books and periodicals from the Internet and then store the material on e-readers. Most of these devices use electronic ink, a display technology that reflects light off the text just as paper does, making e-readers easy to read even in bright light.

A few manufacturers also use LCD technology for their e-readers. Depending on the device, users navigate through functions using either buttons or a touch screen.

Battery life and internal memory are key features and vary widely among e-readers. Some models offer external memory options. Access to content is also a major consideration, with many of the devices now linked to dedicated services with millions of titles, while others provide significantly less choice.

Presentation and Collaboration Tools

Presentation and collaboration are key skill sets that have taken on a larger role in today's classroom. Here's an overview of essential supporting hardware, some of the benefits they offer and issues to consider when your district makes buying decisions.

Projectors: One technology that has become much more versatile in its digital form is the projector. These devices present both still and moving images via a connection to a computer or network. Most modern projectors are based on either digital light processing (DLP) or liquid crystal display (LCD) technology. Each technology has its advocates, so it's important to compare various models before making a choice.

DLP uses microscopic mirrors that, when activated by digital signals, turn toward a light source at varying

angles, producing different levels of light and color. LCD screens are made up of several panes of polarized glass with liquid crystal molecules between the layers. An electric current runs through the molecules, changing their position and creating images with patterns of lightness and darkness.

LCD technology is generally thought to provide slightly better contrast than DLP, but DLP has a faster refresh rate making for sharper moving images. Many projectors offer direct Internet connections, and almost all can be used without a computer by means of USB portable storage devices.

Interactive whiteboards: Teachers in all grades have embraced interactive whiteboards as a learning tool that can transform the classroom. Most interactive whiteboards have a large display that's either mounted on the classroom wall or supported by a stand and upon which a projector throws the image of a computer desktop. System software lets teachers and students write on the display (using either their fingers or a light pen) and manipulate text and images.

Most interactive whiteboards also let users record class input, either as discrete images or, in some cases, by recording entire presentations. Many manufacturers offer features through which content from a whiteboard presentation or interaction can be transferred into other formats, such as Microsoft Word documents, PowerPoint presentations or PDF files.

Teachers report that the systems boost student engagement dramatically and provide a means for ongoing curriculum development and digital content creation. For example, all the annotations and notes from a live presentation may be recorded and thus become new, improved content.

Student response systems: Often used in tandem with interactive whiteboards, student response systems give learners a way to participate in a lesson electronically. Using a handheld wireless device about the size of a TV remote, these "clickers" let students vote on teacher-proposed options, answer multiple choice questions, or even send numerical or text responses.

Software on either the interactive whiteboard system or the teacher's PC tabulates and displays student responses. The applications let teachers view both aggregated and individual responses.

Popular with both students and teachers, the use of student response systems is spreading rapidly. Students are enthusiastic about the instant feedback they give and receive from the systems, and teachers have a tool with which they can evaluate student comprehension in real time.

Document camera: The 21st century version of the overhead projector is the doc camera – but it does a lot more than the older technology. The cameras project live images of

CASE STUDY

TABLETS IN THE CLASSROOM

Learn from the experiences of three schools trying out tablets in the classroom:

CDWG.com/classroomtechcs

THIN, YET RICH IN BENEFITS

Thin clients are personal computing devices that are most notable for what they don't have: a hard disk drive. About the size of a hardback book, a basic thin client contains a CPU with an operating system and a small amount of standard or, more frequently these days, flash memory.

A monitor, keyboard and mouse can be plugged into the thin client chassis, and network ports enable LAN and WLAN connections. Thin clients don't need hard drives because all applications and data available to users are stored on servers in the data center.

Variations on these devices have been around since the days of mainframes, but thin clients are popular again and some school districts are adopting them to streamline maintenance, increase security and save money. Without a hard drive, thin clients have no moving parts to break or wear out.

These solid-state devices generate very little heat, and they are nearly silent, eliminating the background noise of whirring hard drives. Thin clients are relatively inexpensive, easy to replace, and because they don't store applications or data locally, IT departments can configure them faster.

Application installation and upgrades are all handled at the data center, which streamlines systems management. Security is also strengthened and simplified because patches are managed centrally and, with no local applications on user hardware, endpoints are much less vulnerable.

Finally, thin clients use less energy than PCs (an estimated 25 percent to 50 percent less), which means they are both green and save money.

books, pictures, documents and 3D objects, and can enlarge small-scale demonstrations to a size that makes them available to the entire class.

Zoom features let teachers highlight details or specific passages of a text. Most document cameras allow users to capture still images, annotate them and reuse them in presentations, study guides or tests.

Webcams: Instructors can now deliver real-time images to a classroom by using webcams. These devices are often connected to the Internet, where they provide a video link that can be used for conversations, discussions or formal conferencing between users.

Specialized software is available that lets users capture still images with webcams. And educators also have used the devices as document cameras with satisfactory results. Some districts deploy webcams in classrooms and other areas of school buildings as part of their security strategy.

Digital conferencing systems: Students and teachers are no longer bound by location. Digital conferencing systems let teachers and students communicate over the Internet or a local network from separate locations using audio, video, chat, file sharing and remote desktop sharing, as well as share content from interactive whiteboards.

The most elaborate systems include microphones; digital video cameras or webcams; and network connections to tools such as interactive whiteboards, software applications and stored files.

These systems are used increasingly for virtual (distance) learning courses, virtual review sessions for traditional or blended classes, and one-to-one learning and collaboration among teachers or students in separate schools. One advantage of the technology is that it can work even if some of the components are missing on one side of the communication.

For example, if students don't have webcams or microphones, they can answer or ask questions via chat. Adequate bandwidth, especially for video components, is an essential consideration for districts that are contemplating digital conferencing systems.

Software

While strides have been made in classroom hardware options, even greater development has happened with software. Here's a look at essential software for the classroom, some of the benefits they offer and issues to consider when making buying decisions.

Classroom management software: Also known as learning management software, these bundles include tools ranging from simple spreadsheets that help teachers keep track of grades to suites of applications that support a wide range of functions. One set of CMS applications helps manage tasks related to classroom logistics and housekeeping — tracking attendance or recording and sometimes helping to analyze grades and other assessments.

Some have features that help students stay on task by blocking access to distractions, such as social networking sites. Others even help manage digital rights and permissions by tracking licensing agreements and copyrights.

Many classroom management systems offer workflow applications as productivity tools for teachers. Professional development modules that support online communities where teachers can exchange ideas and help each other solve problems are becoming increasingly common in CMS software packages.

Other CMS applications more directly address the educational mission. Some software lets teachers align classroom activities with learning goals and frameworks.

Almost all CMS solutions provide for collaboration, both between students and teachers and peer-to-peer among students in forums such as online discussion groups, blogging platforms and wikis. Tools to create and manage digital content are central to most large CMS suites and are designed to foster student collaboration in the development of digital learning materials.

Classroom management systems let students access digital materials asynchronously and independently. They let them review difficult material or move ahead if they have mastered it. Students demonstrate that they understand the work by taking quizzes or other assessment tools embedded in the software.

Digital content creation software: One staple of the 21st century classroom is digital content creation software. Interactive whiteboards take existing digital content and let teachers and students annotate that content and enhance it using an array of other sources, such as the Internet or student response systems. A document camera also creates digital content in the form of the images it captures.

Most CMS systems include extensive content-creation modules. Stand-alone applications are usually platforms that let users take original content (a Microsoft Word document or PowerPoint presentation) and integrate it with content shared by another collaborating author, downloaded from the Internet or imported from a third-party source. Most of the software includes versioning control to track the development of the specific content. ■

Financing Technology Projects

The need for ongoing research on available funding

4 TIPS FOR GRANT WRITERS

Asking for funding isn't easy. The school must convince the proposal evaluator that it has a specific problem, a detailed strategy for solving it and that it knows how to assess the project's success. Each grant application has different requirements, but there are a few best practices that can boost the chances of securing funding.

- **Know the requirements.** Most grants outline their requirements in a request for proposal. Read the RFP carefully and make sure your school qualifies.
- **Make it a group effort.** Include teachers, administrators and IT staff on the grant writing team.
- **Develop a timeline.** Read the directions carefully and create a realistic timeline that details each step of the process. Add a few days to account for inevitable delays.
- **Give proposal evaluators what they want.** Follow the RFP's requirements to the letter. If the RFP calls for 10 pages, don't submit 11.

Technology promises enormous benefits to the classroom, but schools still have to find the money to pay for it. Fierce competition for funding in an era of ever-shrinking education budgets is forcing school boards to make difficult choices among worthy alternatives. Administrators and IT managers advocating for technology projects need to marshal hard numbers and strong arguments for the new value proposition technology brings to the classroom.

Making the Case

In K–12 education, traditional metrics, such as return on investment (ROI), don't always apply. The value of classroom technology often lies in intangibles, such as fostering engagement and creativity. Standardized tests and other traditional assessment tools don't measure the collaboration or critical-thinking skills central to the new learning model supported by technology.

The Consortium for School Networking (CoSN) is promoting the concept of value of investment (VOI), which is aimed at assessing educational benefits in relation to a project's cost (cosn.org/voi). The Partnership for 21st Century Skills (p21.org) and Project RED (projectred.org) are other organizations working on new approaches to assessing the value of classroom technology.

For now, administrators and IT managers can make their case for projects by clearly articulating how technology supports identified needs and learning goals. Of course,

a comprehensive and realistic calculation of the costs related to a project is a fundamental requirement for any funding request. Be sure to include costs for professional development, installation, overhead and maintenance, along with the basic price of the hardware or software.

Lease or Buy?

Deciding whether to purchase or lease equipment is a significant part of any financial plan for a classroom technology project. Districts should match their own specific needs to the pros and cons of each option before they make a choice.

For cash-strapped school districts, leasing reduces what is often a huge initial outlay and can help get projects off the ground. Some schools find that leasing makes it easier to refresh technology and keep it current. And, when the leasing period is over, recycling and resale are no longer the responsibility of the school district.

However, leasing does incur interest and possibly other fees that add up to a higher total cost for leased equipment than if it were purchased. If the period of the lease is out of sync with the appropriate hardware refresh cycle, the district may still have to manage for a time with outdated technology. Leasing adds an extra layer of administration, and demands close attention to manufacturer policies and buyout plans.

Buying equipment requires funding for upfront costs and leaves the district fully responsible for lifecycle management and upgrades. But purchasing also offers school IT managers the flexibility to reconfigure and update as needs arise, rather than on a preset schedule.

Many veteran IT managers suggest taking a hybrid approach: making capital investments where it seems appropriate and leasing the technology that fits a specific financing arrangement.

MORE GOVERNMENT RESOURCES:

Here are some additional government-backed funding resources to research:

- **DOE:** www2.ed.gov/fund/grants-apply.html
- **DOE Office of School Support and Technology Programs:** www2.ed.gov/programs/innovative
- **U.S. federal government grants:** grants.gov

Government Funding Sources

Grants from government agencies can fund entire projects or offset funding gaps. The federal programs listed below are a good place to start the search for grant money.

Enhancing Education Through Technology (EETT): This program seeks to improve student achievement through the use of technology in K–12 classrooms. Administered by the federal Department of Education's School Support and Technology Programs, EETT grants are available for local activities that include professional development programs and public-private partnerships.

EETT also funds technology-driven curricula that meet state academic standards, as well as technology that improves academic achievement, increases parental involvement and enhances teaching and school improvement through data collection, management and analysis. For more information, visit www2.ed.gov/programs/edtech.

Investing in Innovation Fund (i3): This is a program that offers competitive grants to local educational agencies, as well as to nonprofit organizations working with local educational agencies (LEAs) or a consortium of schools.

Grants from i3 are overseen by DOE's Office of Innovation and Improvement. They are geared to support effective teachers and principals; improve the use of data to accelerate student achievement; promote standards and assessments that prepare students for success in college and careers; and turn around persistently low-performing schools. Three types of grants are available through the i3 program:

- **Development grants** support projects that study new educational concepts. Up to $3 million in funding is provided for each grant.
- **Validation grants** support promising programs that need additional evidence of effectiveness. Up to $15 million is provided for each grant.
- **Scale-up grants** expand programs that have proved their effectiveness. Up to $25 million is provided for each grant.

For more information on federal i3 grants, visit www2.ed.gov/programs/innovation.

Race to the Top: This program rewards states for past accomplishments in education improvement and reform and offers incentives for states to develop strategies to drive school improvement. Race to the Top is administered by the Department of Education's Office of Elementary and Secondary Education (which also administers DOE's School Support and Technology Programs EETT Grants).

Race to the Top grants are awarded in two phases to states where reforms center on the following: adoption of standards and assessments; development of data systems that measure student growth and success; the recruitment, development and retention of effective teachers and principals; and effectiveness in improving low-achieving schools.

Keep in mind that individual school districts provide data and support for Race to the Top applications, but awards are made to the states, which then distribute the funding. For more information, visit www2.ed.gov/programs/racetothetop.

Race to the Top Assessment Program: This program provides grants to consortia of multiple states to develop assessments that support and inform instruction, provide accurate information about student progress and measure student achievement against standards. The program is also managed by the Office of Elementary and Secondary Education (OESE). There are two types of grants available:

- **Comprehensive Assessment Systems grants** for developing standards-based assessment systems are used to prepare students for college and the workplace by measuring their knowledge and skills. Grants are awarded to schools that reflect good instructional practices and support a culture of continuous improvement.
- **High School Course Assessment grants** develop high school course assessment programs promoting high levels of rigor in high school courses across a well-rounded curriculum. Although this program doesn't directly address technology, there are opportunities to include technology for core academic subjects and in career and technical education. For more information, visit www2.ed.gov/programs/racetothetop-assessment.

E-Rate: This program operates as a Federal Communications Commission (FCC) program that offers schools and libraries discounts of 20 percent to 90 percent on telecom services, Internet access, internal connections and basic maintenance of internal connections.

For schools, the percentage of students who are eligible for free and reduced lunches under the National School Lunch Program is the primary measure by which a discount is determined. For more information, visit universalservice.org/sl.

Nonprofit and Corporate Funding Sources

Numerous foundations promote the use of technology. Three in particular are known for supporting technology in education.

The Bill and Melinda Gates Foundation: This nonprofit works to make sure that high school students graduate and are prepared to earn postsecondary degrees. Investments by this foundation focus on developing new technologies and tools to effectively engage and support students, including next-generation classroom technologies and STEM education. For more information, visit gatesfoundation.org/Pages/home.aspx.

The John D. and Catherine T. MacArthur Foundation: This organization awards grants for digital learning. The foundation's Digital Media and Learning Initiative aims to determine how digital media change the way young people learn, play, socialize and participate in civic life.

The program funds research on students and digital media; efforts to develop new learning environments that reflect young people's digital media usage; and projects that build the emerging field of digital media and learning. For more information, visit macfound.org/learning.

Directorate for Computer and Information Science and Engineering (CISE): This is an agency of the National Science Foundation that works to help the United States maintain a leadership position in computing, communications, information science and engineering. The agency manages grant competitions related to computing and information infrastructure research and education. For more information, visit nsf.gov/cise/about.jsp.

Several corporations offer grants aimed specifically at programs that advance science, math and technology education. A number of corporations offer grant assistance to schools, including:

- Intel: intel.com/about/corporateresponsibility/community/giving/usgrants.htm
- Sony: sony.com/SCA/philanthropy/education.shtml
- Sprint: sprint.com/responsibility/education/character ■

ADDITIONAL GRANT SOURCES

Here are some more funding avenues and organizations to consider while researching.

Source	Funding Type	Web URL
Technology Grant News	Tracks educational technology and K–12 grants	technologygrantnews.com/grant-money-index-type.html
Editorial Projects in Education Research Center	Overview of state funding policies	edweek.org/media/eperc_finance_0410.pdf
State Departments of Education	DOE links to state education departments	www2.ed.gov/about/contacts/state/index.html

Infrastructure Support

Carefully assessing the technology needed to deliver today's classroom

Classroom technology works well only when there's a computing infrastructure that supports expanding access to resources and ensures high availability for applications, digital content and data. IT managers need to pay special attention to wired and wireless networks and storage.

Security is also an important consideration. The increasing reliance on network data, mobile devices and open access to the Internet create security risks that didn't exist even five years ago. How IT managers respond to the threats and build and maintain a secure infrastructure is critical to a school district's ability to stay vibrant and competitive.

Network Bandwidth

Bandwidth activity across school networks is expanding rapidly today. Devices on the network are multiplying, as are bandwidth-intensive applications and resources such as streaming video and multimedia. High availability becomes critical when technology is tightly integrated into the classroom. If the network or even one important application is down for a day, lesson plans are put on hold.

With these issues in mind, optimizing the network becomes a priority. There are a few key areas that deserve special focus.

Network management software: Investing in network management software is a good place to start. These systems let IT staff monitor the number of devices on the network, the traffic between devices, and the traffic between devices and applications.

Network management systems also offer a view into the availability of individual applications. They send out notifications when network transmission speeds or application availability approach predetermined performance minimums. Some network management tools even alert network administrators to cabling problems.

These management tools also record the history of traffic on the network and the availability of resources. That record can be an invaluable guide

for adjusting network configuration parameters and can point to the need for redundant elements in the network to support more efficient load balancing.

Load balancing: This refers to techniques that let computing resources share the workload. In the case of the network, load balancers distribute traffic over multiple links and switching points. Most network management software does some load balancing automatically.

Failover: IT staff should also consider the network's failover capability as they build a high availability strategy. Failover usually implies redundant resources, in which a primary server or application is paired with a backup server or another iteration of the application.

In the event of an outage, or if the primary resource becomes so overloaded that performance levels are compromised, the network administrator (or the network management system) makes the service available from the secondary component.

Wireless Access

Exploding bandwidth activity has as much of an impact on wireless access as it does wired networks. Legacy wireless infrastructures based on older 802.11b and g standards simply can't handle the latest Wi-Fi devices that schools are providing, along with student-owned technology arriving on campus as part of the BYOD trend.

Students, teachers and administrators now also expect wireless access to all the bandwidth-intensive resources that are available on the wired network. There are a variety of areas that IT managers can focus on to help meet those expectations.

802.11n: The first step is to move to 802.11n. Wireless N is the latest version of the Wi-Fi protocol developed and ratified by the Institute of Electrical and Electronics Engineers (IEEE). Wireless N boasts theoretical speeds up to 10 times faster than those of 802.11g and offers twice the range of any earlier version.

Additionally, 802.11n is far less susceptible to interference from either physical barriers or electronic equipment. Wireless N enhances both coverage and speeds in wireless networks to widen access and improve the delivery of high-bandwidth applications and content.

Wireless access points and switches: As part of an organization's migration to Wireless N, aging wireless access points and switches should be swapped out. Old versions of the 802.11 standard should be replaced with new hardware based on 802.11n. Wireless N devices are backward-compatible to 802.11a, b and g and pave the way for a migration to an 802.11n network.

Gigabit Ethernet: The next step is upgrading the wireless network to Gigabit Ethernet. Deploying Gig-E switches will significantly enhance a district's ability to deliver high-bandwidth resources. 802.11n Gig-E is becoming the standard in many new wireless installations in both business and educational settings. Most IT consultants recommend that districts move to Gig-E when they reach the end of their current networking hardware's lifecycle.

Wireless LAN controllers: These appliances let network administrators centrally configure management, policy and security settings on numerous wireless access points. WLAN controllers automatically perform load balancing by connecting user devices to multiple access points, a strategy that helps maintain data speeds for high-bandwidth applications.

If they detect interference among the access points, WLAN controllers can adjust radio frequency power and channel assignment to resolve the problem. WLAN controllers also offer network authentication features to limit wireless network access to authorized users.

Storage Management

The rise of online learning and the ever-expanding use of digital content has created an increased need for highly available storage. One of the great benefits of the online learning model is that it's asynchronous. Even if a lecture or presentation is initially streamed live, it remains available for review or for any students who missed the first session.

And it's these bandwidth-intensive video presentations that also add to an organization's storage requirements. School districts with technology-rich learning environments need to revise and update storage strategies, turning to technologies that support high availability and the consolidation of resources. Certain technologies warrant close consideration.

Data deduplication: One way to reduce storage needs and eliminate redundant data is with data deduplication. Stand-alone data deduplication compression tools are available, but the function is usually performed as one feature of a storage management software system.

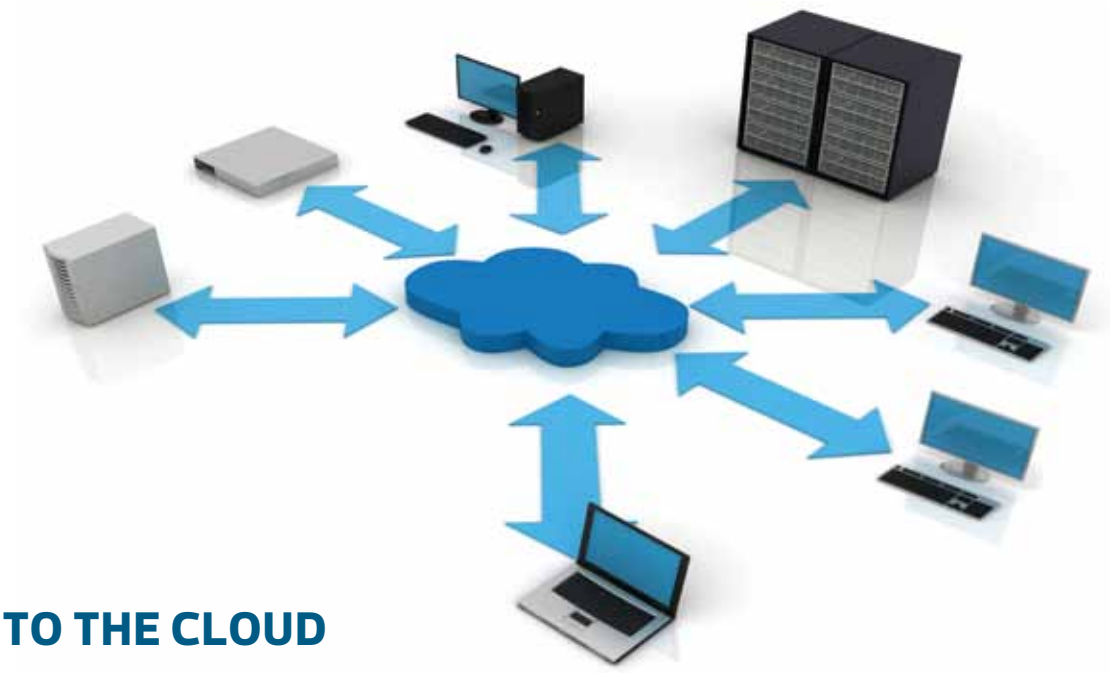
In data deduplication, just one copy of a file or piece of data, rather than multiple iterations, is stored. The other instances are replaced by a pointer that allows users to retrieve the unique saved copy. If the same image is used in several multimedia presentations, it is only stored once.

Not only does this technique save storage space, it also reduces storage costs and provides a longer active life for content, because there is less need to move it to a back-end archive to make room for new content.

Network-attached storage (NAS) and storage area networks (SANs): For school districts looking to offer high availability in an environment that stresses collaboration and shared content, networked storage is the way to go. The most common forms are NAS and SANs.

NAS usually consists of an appliance connected to the district network to which all the users on the network can store data. NAS is simple to deploy and manage, relatively inexpensive compared with a SAN, and easy to add to the network as shared storage requirements grow.

A SAN creates a separate network of storage resources that is then attached to the district's primary network.



INTO THE CLOUD

School districts are starting to use cloud computing strategies to simplify the management of infrastructure, applications and digital content. The New Media Consortium's *Horizon Report: 2011 K-12 Edition* indicates that cloud computing is likely to see widespread adoption in schools in the upcoming year.

By the cloud, the Horizon Report means the vast array of resources and services available on the public Internet, either for purchase or free. Some schools are already turning to hosted services in the public cloud to deliver e-mail, along with other infrastructure functions such as storage and backup. Districts that have made the move into cloud computing report cost savings and reduced demands on IT staff.

Worries about security and control of computing resources on the Internet have led some districts to adopt private or hybrid cloud solutions. A private cloud lets authorized users access shared applications, data and digital content on the local network. The shared resources are available remotely, usually via a virtual private network (VPN).

A hybrid cloud combines access to local network resources with selected resources from the public Internet. The cloud solution creates an extra layer of security and control between the user and Internet applications.

Storage and (more important) retrieval is much faster than is the case with NAS, making SANs nearly the perfect solution to create high availability.

Until recently, SANs were far too expensive and difficult to manage for most K–12 school districts. Some might cost in excess of $500,000 for a large operation. Today, more affordable and easier to manage SANs are available, making them an option that districts with growing content delivery needs should consider.

Storage virtualization: This technology creates a view of all the storage devices on a network and presents them as a consolidated storage resource. The pool of virtualized storage is then managed centrally.

Virtualization typically takes place as one of the embedded features of a SAN, but stand-alone storage virtualization appliances and software are also available that can connect to a network. Storage virtualization cuts the amount of wasted storage on the network. This lets management software or a systems administrator redirect data to underutilized resources.

Backup: Any discussion about storage management also needs to touch on the school's backup strategy. Such a plan should cover digital educational resources as well as personnel and financial information from the school or district office.

As more resources are digitized or move online, the consequences of an outage rise proportionally. IT managers need to develop policies and procedures and make decisions about media and architectures. Many tools are available that support backup management and automation.

Security Awareness

The task of securing networks and the resources on them is getting more challenging as IT infrastructures become more complex. Proliferating mobile devices can be easy targets for infection by viruses that are then passed on to the network. Applications that encourage collaboration can also incubate and spread infections on the network. Hackers, identity thieves and purveyors of all kinds of malware are inventive and relentless.

At the same time, liability issues grow as school communities demand protection for the private data they entrust to district IT departments. Fortunately, there is no shortage of technologies to secure school networks and protect the data of students, teachers and other employees. Schools should direct their focus toward the following technologies.

Virtual private networks (VPNs): For starters, VPNs are dedicated tunnels through the Internet or other public networks that let users have secure remote access to the organization's computing resources. Authentication is required to use the VPN, and traffic is usually encrypted in both directions.

VPNs are critical parts of the security infrastructure for districts that strive for "anytime, anywhere" access to resources for students. Some districts use VPNs as a core element in creating a private cloud of shared computing resources.

Application layer firewalls: IT managers also use application layer firewalls to monitor the input and output traffic of individual applications and services. The firewalls then block any packets that carry known vulnerabilities or traffic with nonconforming features that suggest the presence of a virus. These firewalls deliver more granular protection than session-level firewalls and have become standard for most security strategies.

Network access control (NAC): Really locking down a network requires network access control. NACs are software systems that regulate access to network resources by requiring one or more forms of authentication. In school environments this is usually a password.

Most NACs can also automatically enforce endpoint security policies, blocking access to the network, if a password has not been changed within the period stipulated by use policies. This is a welcome feature for districts that manage a growing number of devices on their networks.

Intrusion prevention system (IPS): This is another important tool that extends network security. An IPS is a security appliance that matches the signatures of traffic traveling into the network with those of known threats and blocks the malicious traffic.

An IPS usually includes extensive logging and reporting capabilities that help IT staff track intrusions. The more sophisticated the IPS, the better it can inspect a growing number of characteristics of the data packets traveling into the network, resulting in increasingly nuanced and foolproof protection.

Content filtering software: For blocking access to inappropriate material on the Internet, content filtering software is also part of the security mix. Most content filtering applications also let users identify keywords whose presence, or multiple use, will then cause the web page to be blocked.

The applications usually come with built-in lists of prohibited sites, but individual schools and districts can customize the blacklists and keywords. Many applications allow network managers to vary the levels of filtering for different user groups. For example, IT managers can let teachers view more sites than students, and provide older students with more access than those in lower grades. ■

CHAPTER 6

Teachers, Technology & Training

Providing guidance on technology use for successful integration in the classroom

Most teachers today are excited about using technology in the classroom. In fact, the CDW•G 2011 *21st Century Classroom Report* found that 75 percent of high school teachers say they regularly use technology to teach. And they're hungry for more high-tech tools: Just 45 percent say the technology in their classrooms meets their expectations.

In the 2010 CDW•G report, faculty who were asked to name essential classroom technologies listed only three: an Internet connection, a computing device for use by the teacher, and an LCD projector. In the 2011 report, the list has grown to include wireless connectivity, interactive whiteboards and access to digital content.

Related data from a 2011 PBS-Grunwald survey of K–12 educators, *Deepening Connections*, indicates that 78 percent of teachers believe that the technology in their classrooms helps them do a better job. These findings and what they suggest about teacher enthusiasm are good omens for the future of effectively deploying technology in the classroom.

Ideally, the learning model in the 21st century classroom should shift from instructor-centric to student-centric — and instructors will be the catalysts for that change. It's teachers who must recognize the full potential of technology to promote collaboration, critical thinking and independent learning. And that means their role changes from ultimate source of information and authority to adviser, content expert and coach.

Navigating that change while managing a classroom full of students is a lot to ask. That's why school districts should invest the time and resources to earn teacher buy-in with support and training at every step of the transformation.

How Technology Changes Teaching

The most fundamental benefit that technology brings to the classroom is student engagement. Undeniably, the "cool" factor plays a part in initially gaining students' attention. An interactive whiteboard can seem pretty magical compared with the standard whiteboard and eraser markers it replaced.

But more to the point, these young students are accustomed to using technology to gather information and interact with the rest of the world. It's simply how they work.

Technology can support the traditional educational mission of acquiring knowledge and mastering skills. Digital content such as Microsoft Word files, PowerPoint presentations, still images, videos, multimedia presentations or captured interactive whiteboard sessions can accelerate learning. Software is available that guides individual students through topics at their own pace, testing mastery in incremental steps before moving on to new material.

Technology can tailor these traditional educational activities to individual students, making lessons more enjoyable and efficient and freeing the teacher to give additional attention to learners who have difficulty with the material.

Technology also supports and fosters communication, collaboration, critical thinking and creativity — competencies that will help students succeed in school and in the workplace. Tools such as interactive whiteboards give lessons an organic life, allowing them to grow as teachers annotate and add elements and as students make their own contributions.

Software tools let students select digital content from a wealth of sources or create their own. Students still write papers in the 21st century classroom, but they can share them online for collaboration and editing by peers. Individuals and groups of students produce multimedia presentations that teach them how to express their ideas clearly and creatively while engaging their audience.

Finally, technology can ease some of the administrative, logistical and housekeeping burdens of teaching. Classroom management systems can help teachers with everything from keeping track of attendance and grades to creating lesson plans and aligning the plans with learning goals.

Harnessing the Power Users

Almost every school has faculty members who are tech-savvy and eager to take advantage of the potential of new hardware and software for the classroom. Because of personal interest, these teachers often have knowledge and experience that help them use new technologies more quickly or easily than their peers.

In some districts with small IT staffs, tech-savvy faculty members already have titles such as "Building Technology Contact." Most often they help solve problems, share their knowledge and informally mentor colleagues.

Administrators and school IT managers should identify these technology leaders and formally place them at the center of professional development initiatives. They are obvious choices to lead workshops or manage online learning communities for educators.

Pair them with teachers who feel less comfortable with technology to help those colleagues gain skills and confidence. Explicitly recognize them as the "go-to" resources for solving problems and developing technology strategies.

Faculty technology leaders are invaluable for pilot programs. Selecting the classrooms of tech-savvy teachers for pilots guarantees an enthusiastic exploration of the new hardware's or software's features. These teachers are likely to offer useful feedback.

THE VALUE OF PROFESSIONAL NETWORKS

Professional learning networks (PLNs) can form valuable connections that let educators share ideas and resources, help one another solve problems and collaborate on projects. In short, they offer ongoing professional development.

All a teacher needs is an Internet connection to access existing networks, such as the Discovery Educator Network (community.discoveryeducation.com) or PBS Teachers Connect (pbs.org/teachers). More specialized communities of interest on specific topics, such as classroom technology, branch off from these larger networks.

Educators can also enlarge their PLNs by connecting with teachers and education thought leaders through blogs and Twitter. As with students in the classroom, engagement and participation are essential for educators who want to make the most of PLNs.

They are also typically less frustrated than many of their peers by the glitches that are bound to beset a pilot. Their technical proficiency often frees them to focus on how using the new technology supports educational goals. Once the general rollout begins, they usually serve as technology evangelists, spreading their knowledge and enthusiasm.

The Role of Administrators

School administrators have the important role of acting as cheerleaders for technology projects and offering moral support to the faculty. Even more important, they provide the time and money required for professional development.

For all the benefits that technology can bring to classrooms, learning how to use the new tools effectively takes time that busy teachers rarely can spare. Administrators can help by making technology training a priority and authorizing faculty to carve out time from their schedules for professional development. School officials should place technology training at the core of the educational mission, rather than as an add-on that steals time and energy from other responsibilities.

According to many experts, one of the top reasons technology projects fail is that the investment in staff development is rarely commensurate with the investment in the actual products. Schools can expect better progress if technology is implemented more slowly or on a smaller scale, with part of the budget directed toward increased training and support for teachers.

It's also crucial for administrators to consistently build professional development into the budget, not just during or immediately after a specific technology project. Invest in training sessions run by outside experts, and provide financial support for teachers to attend relevant conferences and workshops. Administrators can expect these investments to pay off in more creative and effective use of technology for learning.

Cultivating a Training Culture

More often than not, professional development related to classroom technology stops as soon as educators know how to push the buttons of their new hardware or click through the pages of the latest software application. Teachers are left to figure out on their own how the technology supports learning goals, and how it fits in with the art and craft of teaching.

Effective professional development should present best practices and offer specific examples of activities and lesson plans that exploit the capabilities of technology tools. It should also create or direct teachers toward forums where they can share ideas and together explore the potential of the available technologies.

Tools come and go, but technology in the classroom is here to stay, reflecting its integration into almost all other aspects of modern life. Technology is already shifting the paradigm of education toward an increased emphasis on collaboration, critical thinking and creativity.

More change lies ahead as technology evolves. The benefits of that evolution will emerge as educators take advantage of training opportunities, collaborate on new strategies and continue to mentor and coach one another. ■

ONLINE RESOURCES FOR TEACHERS

A wealth of Internet resources exists for educators interested in teaching with technology. These are some good places to start:

- **The Consortium for School Networking** (cosn.org) is valuable for its focus on district administrators and how they can support classroom technology.
- **The International Society for Technology in Education** (iste.org) offers professional development resources and services and is the gateway to several professional learning networks related to classroom technology.
- **EdTechTeacher** (edtechteacher.org) helps teachers and schools leverage technology to create student-centered learning environments.
- **4teachers.org** is one of many websites devoted to sharing technology-based lesson plans, digital content and online assessment tools.

This glossary serves as a quick reference to some of the essential terms touched on in this guide. Please note that acronyms are commonly used in the IT field and that variations exist.

Glossary

Acceptable-use policy (AUP)

An acceptable-use policy is a set of rules determined by the owner or manager of a network. AUPs govern issues such as security and the conduct of users on the network and generally spell out content and behaviors that are prohibited from the network.

Backup

In computing systems, backup is the process of making copies of data and storing them separately from originals. The copies are then used to restore the data in the event the originals are lost in a disaster or outage. Hard backup systems rely on either tape or disk media. Cloud backup services are seeing increasing popularity.

Bandwidth

In computer networks, bandwidth is the amount of data carried from point to point in a given period of time, usually one second. The term is often used interchangeably with the phrase "data transfer rate."

Blended learning

A blended approach combines traditional face-to-face classroom teaching with online and other computer-mediated learning activities, with the goal of harnessing the advantages of both methods.

Broadband

This term is often used as shorthand for "Internet broadband," which refers to a high-speed connection to the Internet. The National Broadband Plan in the United States aims to offer all of the nation's households access to 100-megabits-per-second connections.

Cloud computing

This approach to computing is typically either the delivery of hosted virtualized services over the Internet, or shared virtualized resources on a private network. Cloud computing resources are generally available on demand from any device with an Internet connection.

Cyberbullying

Cyberbullying is the use of technology to harass, threaten, embarrass or in any way target another person. This type of harassment is particularly pernicious because it's hard for the victim to escape, given how large a role technology plays in the lives of young people.

Digital content

This is a commonly used umbrella term for information that's stored in a digital format — items such as word processing or spreadsheet documents, PDF files, audio or video files, and photos or illustrations. Users can store digital content locally on portable media or on networked servers, or it can be accessed via the Internet.

Digital native

Marc Prensky, a writer who focuses on education and technology, coined the term *digital native* in 2001 to describe the generation born after the current age of technology began.

Emerging technologies

These are technologies that are in the early stages of adoption, either in general or in a specific sector, such as K–12 education. The New Media Consortium's annual *Horizon Report: K–12 Edition* identifies emerging technologies as those that it expects will be used widely within the next one to five years. Examples include mobile devices, augmented reality and e-books.

Failover

A key consideration in any high-availability strategy, failover is the process that facilitates automatic switching to a standby computing resource (for example, a server, application or even a network) in the event of an outage to the primary resource. The switch to the secondary resource should be transparent to the user.

Formula grant

A formula grant program is a noncompetitive federal award based on a predetermined formula that considers economic and demographic factors in the applying community.

High availability

High availability refers to an application, service or system that is designed to meet predetermined standards of continuous operation. In relation to classroom technology, high availability means having sufficient network bandwidth and resources to deliver services on demand to teachers and students.

Infrastructure

When discussing technology, infrastructure is assumed to encompass the physical environment needed to support networking, hardware and software applications, as well as support services, professional development, and technology policies and procedures.

Malware

Malware is a general term for malicious software — for example, coding and scripts designed to disrupt or block the operation of computer or network systems, illicitly gather information that leads to loss of privacy or criminal exploitation, or gain unauthorized access to system resources.

Network optimization

Network optimization includes a variety of techniques to maximize the amount of data that can be moved across the network and the speed at which data can be transferred. These techniques include load balancing, traffic shaping, data deduplication and compression technologies, among others.

One-to-one computing

A one-to-one project is an initiative through which every student in a class, school or district is provided a personal computing device. Most one-to-one programs issue notebook computers, netbooks or tablet PCs.

Personal learning network (PLN)

A PLN is a community of users who come together to share and learn about issues of common interest. Also known as learning communities, online learning communities or knowledge communities, these groups can include teachers, students, administrators and parents.

Smartphone

A smartphone differs from a basic cellular telephone by offering computing functionality and Internet access. Most include digital voice services, text messaging, e-mail, web browsing, audio and video streaming, and other applications.

Social media

Very much in the news today, social media are web-based technologies that facilitate interactive communication and the sharing of resources among users, creating a social network of connections. Social media types include collaborative projects, content communities and social networking sites. Examples include Facebook, Twitter, blogs and wikis.

STEM

The acronym STEM refers to the teaching of science, technology, engineering and mathematics. Collectively, these fields are widely regarded as the cornerstones of a 21st century education.

Student-centered learning

This term refers to an approach to education that focuses on a student's needs, abilities, interests and learning styles, with the teacher serving as a learning facilitator. Student-centered learning requires students to be active, responsible participants in their own learning.

Value of investment (VOI)

VOI is a measure by which schools and districts can examine the costs and benefits of technology projects. As defined by the Consortium for School Networking, VOI evaluates a technology project's anticipated costs weighed against its potential benefits.

Virtualization

Most simply, virtualization is the creation of a virtual version of an actual or physical computing resource, such as a server, storage array or even an operating system. Virtualization makes cloud computing possible, as only virtualized services are available in the cloud.

Virtual learning

Also called distance learning or online learning, virtual learning uses computer hardware and software, along with a local network or Internet connection to deliver instruction to students. In some virtual learning environments, students direct themselves through curriculum delivered by a software application, usually with an instructor available online for consultation and guidance.

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