part one

INTRODUCTION AND BACKGROUND ON INTEGRATING TECHNOLOGY IN EDUCATION

As we look today at what is happening with technology—and what the future promises—in classrooms across the country, we see that some of the most innovative and promising practices in education involve technology, and the promise of even more exciting capabilities foreshadows great benefits for teachers. This book presents some of the most powerful and capable educational technology resources available today and demonstrates how teachers can take advantage of them. However, teachers must make a considerable investment of their time to prepare themselves to use technology resources well. The first two chapters in this book introduce the world of educational technology and review the knowledge and skills teachers need to prepare themselves to apply educational technology, especially computer technology, effectively in their classrooms. In Part 1, two chapters provide important foundational information and skills to help teachers take the first steps toward using technology in classrooms.

01 EDUCATIONAL TECHNOLOGY IN CONTEXT: THE BIG PICTURE

- Adapting for Special Needs: Assistive Technologies and Universal Design Resources
- Open-Source Options: Electronic Portfolios
- Hot Topic Debate: Social Networking as Distraction?
- Top Ten Issues Shaping Today's Technology Uses in Education

02 THEORY INTO PRACTICE: FOUNDATIONS FOR EFFECTIVE TECHNOLOGY INTEGRATION

- Adapting for Special Needs: Universal Design for Learning
- Open-Source Options: Assessment Tools for Teachers
- Hot Topic Debate: Is Constructivism a "Failed Approach?"

01

EDUCATIONAL TECHNOLOGY IN CONTEXT

THE BIG PICTURE

It is clear that educational technology is essentially the product of a great historical stream consisting of trial and error, long practice and imitation, and sporadic manifestations of unusual individual creativity and persuasion.

Paul Saettler, *The Evolution of American Educational Technology* (1990)

outcomes

After reading this chapter and completing the learning activities, you should be able to:

1. Describe past and current perspectives on educational technology that help define it and shape its uses in schools, and give definitions for educational technology, instructional technology, and integrating educational technology as they will be used in this textbook.
2. Identify periods in the history of digital technologies to date and describe what we have learned from past applications and decisions about their uses.
3. Place a given educational technology resource in one of the following general hardware (microcomputer, handheld, display, imaging, peripheral, or external storage) or software (instructional, productivity, and administrative) categories.
4. Explain the impact of each of the following types of issues on current uses of technology in education: societal, educational, cultural/equity, and legal/ethical.
5. Identify examples of technology literacy and other 21st century skills that teachers and their students need in order to be prepared for future learning and work tasks, and select a teaching portfolio format from available technology-based platforms to document your accomplishment of these skills.
6. Generate a personal rationale for using technology in education based on findings from research and practice on types of problems that technology applications can solve.
7. Identify trends in emerging technologies and the implications they may have for teaching and learning.

key terms

- **Acceptable Use Policy (AUP)**
- **Adequate Yearly Progress (AYP)**
- **artificial intelligence (AI)**
- **augmented reality**
- **clickers (or student response systems)**
- **cloud computing**
- **computer-assisted instruction (CAI)**
- **computer-managed instruction (CMI)**
- **crowdsourcing**
- **cyberbullying**
- **cybercheating**
- **cyberporn**
- **Digital Divide**
- **ebooks**
- **educational technology**
- **electronic portfolios**
- **firewalls**
- **gesture-recognition systems**
- **hackers**
- **hacking**
- **handheld technologies**
- **hardware**
- **i-dosing**

TECHNOLOGY INTEGRATION IN ACTION: THEN AND NOW

THEN . . .

Anna was almost as proud of her new classroom computers as she was of her new teaching degree. She had high hopes for the 1978–1979 school year in her first teaching position, especially since the principal had asked her if she could use two brand-new Apple computer systems that had been donated to the school. As a student teacher, she had helped children use computer-assisted instruction (CAI) on terminals that were located in the school's computer lab and connected by telephone lines to her university's big mainframe computer, but this would be much different. Now the computers would be located right in her classroom, and how she used them would be completely up to her. With her new skills and these marvelous devices at her disposal, she felt a heady sense of power and anticipation.

She found some free and "shareware" drill-and-practice and instructional game software packages, and successfully lobbied the principal to buy others. She planned to buy yet more with money she would raise from bake sales. All the students wanted to use the computers, but with only two machines, Anna quickly devised activities that allowed everyone to have a turn. She had "relay-race math practices" to help students prepare for tests, and she created a computer workstation where they could play math games as a reward for completing other activities and where she could send students in pairs to practice basic skills.

As Anna used her new computers, she coped with a variety of technical problems. Some of the software was designed for an earlier version of the Apple operating system, and each disk required a format adjustment every time it was used. Programs would stall when students entered something the programmers had not anticipated; students had to either adjust the code or restart the programs. Despite these and other difficulties, by the end of the year Anna was still enthusiastic about her hopes, plans, and expectations. She felt she had seen a glimpse of a time when computers would be an integral part of everyday teaching activities. She planned to be ready for the future.

NOW . . .

As she prepared to begin another school year, Anna found it difficult to believe it had been over 30 years since that first pioneering work with her Apple microcomputers. This school year, she had received a set of mobile devices and an interactive **whiteboard,** a device that would allow her to project information from a computer to a screen and then manipulate it either with special pens or hands. The school district had offered these tools to any teachers who proposed innovative ways to engage girls and minority students in math and science projects. With these devices, it would be so much easier for her students to access online math manipulatives and science simulations and collaborate with students in other locations. Her class' favorite activity this year was

information and communication technology (ICT)
instructional technology
integrating educational technology
Internet
laptop computer
logic bombs
malware
meta-analysis
microcomputers
mobile devices
netbooks
one-to-one computing
phishing
portfolio
radio frequency identification (RFID)
sexting
software
software piracy
spam
spyware
storage media
technology education
Trojan horses
virtual schooling
viruses
whiteboard (or interactive whiteboard)
World Wide Web
worms
zombies

© Fotolia

working with students around the state to gather and compare data on local environmental conditions, but they also liked the spreadsheet software's "Buy a Car" activity.

Anna also marveled at how most other teachers in the school were using technology in productive ways. Everyone communicated via email or online chats, and many, like herself, had their own, school-approved social network site so that students and parents could get up-to-date information on school and classroom activities. Students were using graphing calculators to solve problems, and they used online programs to practice foreign languages. She often heard them talking about webquests and virtual field trips they were doing in science and social studies. A video project to interview war veterans had drawn a lot of local attention, and the student projects displayed on school bulletin boards were ablaze with screen captures from websites and images students had taken with digital cameras.

There were still problems, of course. Computer viruses and spam sometimes slowed the district's network, and the firewall that had been put in place to prevent students from accessing undesirable Internet sites also prevented access to many other, perfectly good sites. Teachers reported intermittent problems with online bullying and inappropriate postings on social network sites. Some teachers complained that they had no time for innovative technology-based projects because they were too busy preparing students for the new state and national tests that would determine their schools' Adequate Yearly Progress (AYP) and their own teacher effect scores.

Yet despite these concerns, Anna was amazed at how far educational technology had come from those first, hesitant steps in the classroom, and how much more there still was to try. She knew other teachers her age had retired, but she was too interested in what she was doing to think about that. She had been asked to lead a team of teachers in designing a virtual course for homebound students. Not a day went by that a teacher didn't come to her for help with a new Internet site or video project. She couldn't wait to see what challenges lay ahead. She looked forward to the future.

INTRODUCTION: THE "BIG PICTURE" ON TECHNOLOGY IN EDUCATION

Today's educators tend to think of educational or instructional technology as devices or equipment—particularly the more modern, digital devices, such as computers, cell phones, and iPads. But, as educational technology historian Paul Saettler (1990) noted in this chapter's opening quote, educational technology is not new at all, and it is by no means limited to the use of devices. Modern tools and techniques are simply the latest developments in a field that some believe is as old as education itself. This chapter begins our exploration of educational technology with an overview of the field, from the early perspectives that shaped and defined it to the tools and conditions that determine the role it is able to play in today's society.

Why We Need the "Big Picture"

The "big picture" review in this section serves an important purpose: It helps new learners develop mental pictures of the field, what Ausubel (1968) might call cognitive frameworks, through which to view all applications and consider best courses of action. Several types of information help form this framework.

Key terminology. Talking about a topic requires knowing the vocabulary relevant to that topic. The term educational technology and related terms are not defined the same by everyone. Educators who want to study the field must recognize that language used to describe technology reflects differing perspectives on the appropriate uses of educational technology.

Reflecting on the past. Showing where the field began helps us understand where it is headed and why. Reviewing changes in goals and methods in the field over time provides a foundation on which to build even more successful and useful structures to respond to the challenges of modern education.

Considering the present. The current role of educational technology is shaped primarily by two factors: available technology resources and our perspectives on how to make use of them. Available technologies dictate what is possible; a combination of social, instructional, cultural, and legal issues influence the directions we choose to take.

Looking ahead to the future. Technology resources and societal conditions change so rapidly that today's choices are always influenced as much by emerging trends as by current

Table 1.1 Perspectives on Educational Technology and Organizations That Represent Them

Association for Education Communications and Technology (AECT) http://www.aect.org	International Technology and Engineering Educators Association (ITEEA) http://www.iteaconnect.org	International Society for Technology in Education (ISTE) http://www.iste.org
Perspectives on Educational Technology		
Initially focused on technology as audiovisual (AV) devices and media for library-media specialists and librarians; now focuses on using any resources in ways that improve teaching and learning	Initially focused on skills with manufacturing, printing, woodworking, and metals; then on technology-related careers and promoting technological literacy; now focuses on STEM (Science, Technology, Engineering, Math) education/careers	Initially focused on computer systems to support and deliver instruction; now focuses on all electronic devices and systems to support teaching and learning
Former Organization Names		
None	Until 1980s: American Industrial Arts Association, then the International Technology Education Association	Until 1988: the International Council for Computers in Education (ICCE)
Current Stated Definitions for Educational Technology		
Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources.	*Technology education* is problem-based learning utilizing math, science and technology principles.	*Educational technology* is the full range of digital hardware and software used to support teaching and learning across the curriculum.

conditions. To be informed citizens of an Information Society, teachers must be futurists.

Perspectives That Define Educational Technology

Saettler (1990) says that the earliest references to the term educational technology were by radio instruction pioneer W. W. Charters in 1948, and instructional technology was first used by audiovisual expert James Finn in 1963. Even in those early days, definitions of these terms focused on more than just devices and materials. Saettler notes that a 1970 Commission on Instructional Technology defined educational technology as both “the media born of the communication revolution which can be used for instructional purposes” (p. 6) and “a systematic way of designing, carrying out, and evaluating the total process of learning and teaching” (p. 6). As the 1970 commission concluded, a broader definition of educational technology that encompasses both tools and processes “belongs to the future” (Saettler, 1990, p. 6).

If educational technology is viewed as both processes and tools, it is important to begin by examining four different historical perspectives on these processes and tools, all of which have helped shape current practices in the field. These influences come to us from four areas of education and society, each with a unique outlook on what educational technology is and should be. Some of these views have merged over time, but each retains a focus that tends to shape integration practices. These four views and the professional organizations that have represented them are summarized in Table 1.1.

Perspective #1: Educational technology as media and audiovisual communications. This perspective grew out of the audiovisual (AV) movement in the 1930s, when higher education instructors proposed that media such as slides and films delivered information in more concrete, and therefore more effective, ways than did lectures and books. This movement produced audiovisual communications, or the “branch of educational theory and practice concerned primarily with the design and use of messages that control the learning process” (Saettler, 1990, p. 9). The view of educational technology as delivery media has dominated areas of education and the communications industry.

Perspective #2: Educational technology as instructional systems and instructional design. This view originated with post-World War II military and industrial trainers who were faced with preparing large numbers of personnel quickly. Based on efficiency studies and learning theories from educational psychology, they advocated using more planned, systematic approaches to developing uniform, effective materials and training procedures. Their view was based on the belief that both human (teachers) and non-human (media) resources could be part of an efficient system for addressing any instructional need. Therefore, they equated "educational technology" with "educational problem solutions."

Perspective #3: Educational technology as vocational training. Also known as **technology education,** this perspective originated with industry trainers and vocational educators in the 1980s. They believed (1) that an important function of school learning is to prepare students for the world of work in which they will use technology, and (2) that vocational training can be a practical means of teaching all content areas, such as math, science, and language. This view brought about a major paradigm shift in vocational training in K–12 schools away from industrial arts curricula centered in woodworking/metals and graphics/printing shops and toward technology education courses taught in labs equipped with high-technology stations, such as desktop publishing, computer-assisted design (CAD), and robotics systems.

Perspective #4: Educational technology as computer systems (a.k.a. educational computing and instructional computing). This view began in the 1950s with the advent of computers and gained momentum when they began to be used instructionally in the 1960s. As computers began to transform business and industry practices, both trainers and teachers began to see that computers also had the potential to aid instruction. From the time computers came into classrooms in the 1960s, until about 1990, this perspective was known as educational computing and encompassed both instructional and administrative support applications.

At first, programmers and systems analysts created all applications. But by the 1970s, many of the same educators involved with media, AV communications, and instructional systems also were researching and developing computer applications. By the 1990s, educators began to see computers as part of a combination of technology resources, including media, instructional systems, and computer-based support systems. At that point, educational computing became known as educational technology.

How This Textbook Defines Technology in Education

Each of these four perspectives on technology in education has contributed to the current body of knowledge about processes and tools to address educational needs. Since an informed use of educational technology must focus on all of these perspectives, this textbook attempts to merge them in the following ways:

- **Processes**—For the processes, or instructional procedures for applying tools, we look to (1) learning theories based on the sciences of human behavior, and (2) applications of technology that help prepare students for future jobs by teaching them skills in using current tools, as well as skills in "learning to learn" about tools of the future that have not yet been invented—or even imagined.
- **Tools**—This textbook looks at the roles technology tools play as delivery media, instructional systems, and technology support, and focuses primarily on those tools that play a current, high-profile role in supporting teaching and learning.

In today's technology-driven society, new technology tools and new versions of older tools are emerging at a dizzying rate. Taking advantage of the power of these tools requires both up-to-date information on their features and capabilities, as well as overarching guidelines and procedures for analyzing and matching them to educational problems and needs. It is with this combination in mind that this text assigns the following "evolving" definitions:

- **Educational technology** is a combination of the processes and tools involved in addressing educational needs and problems, with an emphasis on applying the most current digital and information tools.
- **Integrating educational technology** refers to the process of determining which digital tools and which methods for implementing them are the most appropriate responses to given educational needs and problems.
- **Instructional technology** is the subset of educational technology that deals directly with teaching and learning applications (as opposed to educational administrative applications).

YESTERDAY'S EDUCATIONAL TECHNOLOGY: HOW THE PAST HAS SHAPED THE PRESENT

Though a "technology" can be anything from a pencil to a virtual environment, the modern history of technology in education has been shaped in large part by developments in digital technologies, such as computers. The four eras in the history of digital technologies are given in this section, followed by a description of what we have learned from the past that can help us become more effective technology users today.

A Brief History of Digital Technologies: Four Eras

When integrated circuits made computers both smaller and more accessible to teachers and students beginning in 1975, small, stand-alone, desktop computers called **microcomputers** became a major turning point in the history of the field of educational technology. Many of today's teachers began using computer systems only since microcomputers came into common use, but as the timeline in Figure 1.1 shows, a thriving educational computing culture predated microcomputers by 20 years. And though most of the history of technology in education is told in the periods before and after that development (Niemiec & Walberg, 1989; Roblyer, 1992), there were other eras to come. First, the **Internet,** which was already a worldwide collection of computer networks that could exchange information by using a common software standard, became even more functional. The **World Wide Web,** introduced in 1993 as a system of connecting Internet sites through hypertext links, transformed the field and marked the beginning of the third era of educational technology. The fourth and current era was made possible by mobile technologies that offered ubiquitous communications and access to the power of computers and the Internet from any location.

The pre-microcomputer era. Although this era's computer resources were very different from those of today, both computer companies and educators learned much at this time about the role technology was destined to play in education and who could best shape that role. IBM was a pioneer in this field, producing the first instructional mainframe with multimedia learning stations: the IBM 1500. By the time IBM discontinued it in 1975, some 25 universities were using this system to develop **computer-assisted instruction (CAI)** materials. The most prominent of these efforts was led by Stanford University professor and "Grandfather of CAI" Patrick Suppes, who developed the Coursewriter language to create reading and mathematics drill-and-practice lessons. Other similar company- and university-led instructional initiatives ensued. The most prominent were the Computer Curriculum Corporation (CCC, founded by Suppes) and the Programmed Logic for Automatic Teaching Operations (PLATO) system (developed by the Control Data Corporation).

For about 15 years, these mainframe and minicomputer CAI systems dominated the field. Universities also developed instructional applications for use on these systems. Among these were Brigham Young University's Time-shared Interactive Computer-Controlled Information Television (TICCIT) system, and **computer-managed instruction (CMI)** systems based on mastery learning models, such as the American Institutes for Research's Program for Learning in Accordance with Needs (PLAN) and Pittsburgh's individually prescribed instruction (IPI). However, these systems were both expensive to buy and complex to operate and maintain, and school district offices began to control their purchase and use. But by the late 1970s, it was apparent that teachers disliked the control of CAI/CMI applications by both district data processing and industry personnel; they began to reject the idea that computers would revolutionize instruction on a business office model.

The microcomputer era. The introduction of microcomputers in the mid-1970s wrested control of educational computers from companies, universities, and school districts and placed them in the hands of teachers and schools. Several initiatives emerged to shape this new teacher-centered control: a software publishing movement that catered to educators quickly sprang up; organizations emerged to review software and help teachers select quality products; and professional organizations, journals, and magazines began to publish software reviews. As teachers clamored for more input into courseware design, companies created authoring languages and systems (e.g., PILOT, SuperPILOT, GENIS, PASS), but teacher authoring soon proved too time consuming, and interest faded. As schools searched for a way to make CAI more cost effective, districts began to purchase networked integrated learning systems (ILSs) with already developed curriculum to help teachers address required curriculum standards. Control of computer resources moved once again to central servers in school district offices.

Three other technology initiatives also became prominent in this era. First, computer literacy skills began to be required in school and state curricula, spurred on by computer education experts, including Arthur Luehrmann, who coined the term computer literacy. However, this emphasis was eventually dropped due to difficulties in defining and measuring these skills. Second, companies such as ABC News and the Optical Data Corporation joined forces to offer curriculum on videodiscs, both standalone (Level 1) and connected to microcomputers (Level 3). But, when other forms of optical and digital storage replaced videodisc technology, these curricula were not transferred. A final focus in the field was teaching the Logo programming language, developed by Seymour Papert (1980). The Logo view—that computers should be used as an aid to teach problem solving—began to replace CAI as the "best use" of computer technology. Yet despite its popularity and research showing it could be useful in some contexts, researchers could capture no impact from Logo use on mathematics or other curriculum skills, and interest in Logo, too, waned by the beginning of the 1990s.

The Internet era. Just as teachers seemed to be losing interest once again in computer technology's potential for instruction, the first browser software (*Mosaic*) transformed a formerly text-based Internet into a combination of text and graphics. By the last part of the 1990s, teachers and students joined the throng of users on the "Information Superhighway." By the beginning of the 2000s, email,

ROBL2258_CH01.indd 7 11/18/11 4:21 PM

FIGURE 1.1 Digital Technologies in Education: A Timeline

PRE-MICROCOMPUTER ERA

1950

First computer used for instruction

Computer-driven flight simulator trains MIT pilots

© U.S. Air Force

1959

First computer used with school children

IBM 650 computer teaches binary arithmetic in NYC

1960–1970

University time-sharing systems

Faculty/students in universities across the country use mainframe systems for programming and shared utilities

© IBM Corporation

MICROCOMPUTER ERA

1977

First microcomputers enter schools

Using desktop systems, classroom teachers begin to take back control of instructional and administrative applications from district data-processing offices

© Apple Computer

1980s

Microcomputer applications spawn movements

Field focuses on software publishing initiatives and teacher authoring software. The computer literacy computers-as-tools approach gives way to Logo's computer-based, problem-solving approach

mid 1980s–1990s

Integrated learning systems (ILSs) emerge

Schools begin to see ILS networked systems as cost-effective solutions for instruction to address required standards; marks movement away from stand-alone systems and toward central server with connected computers

© Tom Watson/Merrill Education

MOBILE TECHNOLOGIES

2005

Social networking sites, such as Facebook, gain popularity

© Shutterstock

2007

Amazon releases first Kindle ebook reader

© Shutterstock

2008

Partnership for 21st Century Skills creates framework

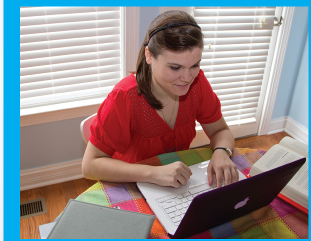


Photo by W. Wiencke

2010

Apple releases first iPad handheld computer

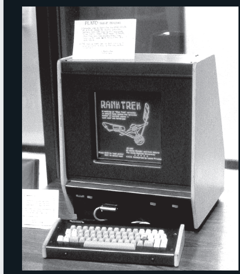
Photo by W. Wiencke.

early
1970s

Computer-assisted instruction (CAI) movement emerges

Large-scale, federally funded university projects use mainframe/minicomputer systems with schools

mid-to-late
1970s



Mainframe and mini-computer applications dominate field

Schools begin using computers for instruction and administration CDC President William Norris (1977) announces PLATO will revolutionize instruction

Courtesy of Wikipedia

late
1970s

CAI movement declines; computer literacy movement begins

Arthur Luehrmann coins term computer literacy for skills in programming and using software tools (e.g., word processing) Molnar (1978) warns that non-computer literate students will be educationally disadvantaged

INTERNET ERA

1993

World Wide Web (WWW) is born

First browser (*Mosaic*) transforms a formerly text-based Internet into a combination of text and graphics. Teachers enter the "Information Superhighway"

© Pearson Learning Photo Studio

1994

Internet use explodes

Online and distance learning increases in higher education, then in K–12 schools educationally is advantaged

© Sam Craft/AP Images

1995

Virtual schooling begins

1998

International Society for Technology in Education (ISTE) creates standards

ISTE sponsors creation of National Educational Technology Standards (NETS) to guide technology skills, first for students, then for teachers and administrators

online (i.e., web-based) multimedia, and videoconferencing became standard tools of Internet users. Websites became a primary form of communication for educators, and distance education became a more prominent part of instructional delivery at all levels of education. The meaning of "online" changed from simply being on the computer to being connected to the Internet. **Virtual schooling,** or "instruction in which (K–12) students and teachers are separated by time and/or location and interact via computers and/or telecommunications technologies" (National Forum on Education Statistics, 2006, p. 1) emerged in both state-sponsored and privately held forms around 1995. It immediately began a steady growth that would see it become a mainstay of public education in the 2000s.

Mobile technologies: the era of ubiquitous access. In the early 2000s, portable devices such as the Apple iPhone and iPad made Internet access and computer power ubiquitous. As more and more individuals added data plans to their cellular phones and made texting and social networking sites part of their everyday lives, this constant connectedness had a transformative impact on educational practice. No longer does one need to be tethered to an Ethernet cable to be connected to the world. This ease of access to online resources and communications has driven a dramatic increase in the number and type of distance learning offerings, first in higher education and then in K–12 schools. Electronic books, or **ebooks,** which are texts in digital form, are available on computers, ebook readers, and cell phones and have become more prominent alternatives to printed texts. As ubiquitous communications and social networking define social practices in modern life, educators struggle to create appropriate policies and uses that can take advantage of this new power while minimizing its risks and problems.

What We Have Learned from the Past

In no small part, developments in digital technologies have shaped the history of educational technology. However, knowing the history of educational technology is useful only if we apply what we know about the past to future decisions and actions. What have we learned from more than 60 years of applying technology to educational problems that can improve our strategies now? Educators are encouraged to research and develop their own conclusions from the history of educational technology. However, the following points also are important:

No technology is a panacea for education. Great expectations for products such as Logo and ILSs have taught us that even the most current, capable technology resources offer no quick, easy, or universal solutions. Computer-based materials and strategies are usually tools in a larger system and must be integrated carefully with other resources and with teacher activities. Planning must always begin with this question: What specific needs do my students and I have that (any given resources) can help meet?

Teachers usually do not develop technology materials or curriculum. Teaching is one of the most time- and labor-intensive jobs in our society. With so many demands on their time, most teachers cannot be expected to develop software or create complex technology-based teaching materials. In the past, publishers, school or district developers, or personnel in funded projects have provided this assistance; this seems unlikely to change in the future, even for distance education courses.

"Technically possible" does not equal "desirable, feasible, or inevitable." A popular saying is that today's technology is yesterday's science fiction. But science fiction also shows us that technology brings undesirable—as well as desirable—changes. For example, distance technologies have allowed people to attend professional conferences online, rather than traveling to another location; however, people continue to want to travel and meet face to face, even though we can simulate face-to-face communication to an increasingly realistic degree. All of these new technological horizons make it evident that it is time to analyze carefully the implications of each implementation decision. Better technology demands that we become critical consumers of its power and capability. We are responsible for deciding just which science fiction becomes reality.

Technologies change faster than teachers can keep up. History in this field has shown that resources and accepted methods of applying them will change, often quickly and dramatically. This places a special burden on already overworked teachers to continue learning new resources and changing their teaching methods. Gone are the days—if, indeed, they ever existed—when a teacher could rely on the same handouts, homework, or lecture notes from year to year. Educators may not be able to predict the future of educational technology, but they know that it will be different from the present; that is, they must anticipate and accept the inevitability of change and the need for a continual investment of their time.

Older technologies can be useful. Technology in education is an area especially prone to what Roblyer (1990) called the "glitz factor." With so little emphasis on finding out what actually works, anyone can propose dramatic improvements. When they fail to appear, educators move on to the next fad. This approach fails to solve real problems, and it draws attention away from the effort to find legitimate solutions. Worse, teachers sometimes throw out methods that had potential but were subject to unrealistic expectations. The past has shown that teachers must be careful, analytical consumers of technological innovation, looking to what has worked in the past to guide their decisions and measure their expectations in the present. Educational practice tends to move in cycles, and "new" methods often are old methods in new guise. In short, teachers must be as informed and analytical as they want their students to become.

Teachers always will be more important than technology. The developers of the first instructional computer systems in the 1960s foresaw them replacing many teacher positions; some advocates of today's distance learning methods envision a similar impact on future education. Yet good teachers are more essential now than ever. One reason for this was described in Naisbitt's (1984) *MegaTrends*: "whenever new technology is introduced into society, there must be a counterbalancing human response . . . the more high tech [it is], the more high touch [is needed]" (p. 35). We need more teachers who understand the role technology plays in society and in education, who are prepared to take advantage of its power, and who recognize its limitations. In an increasingly technological society, we need more teachers who are both technology savvy and child centered.

TODAY'S EDUCATIONAL TECHNOLOGY RESOURCES: SYSTEMS AND APPLICATIONS

Digital technology may be thought of as systems, or combinations of hardware and software applications. The resources described in this section, along with current conditions in schools and society described in the next section,

ROBL2258_CH01.indd 10 11/18/11 4:21 PM

help define and shape the current climate for technology in education.

An Overview of Digital Technology Tools

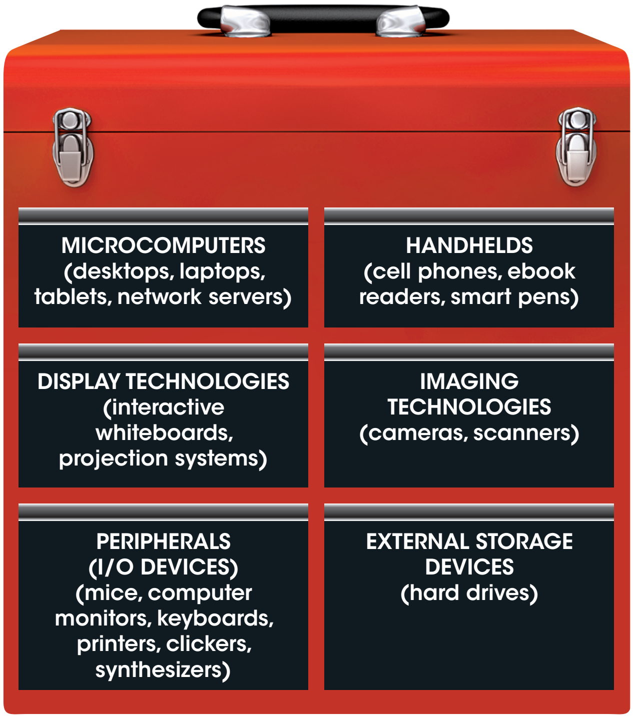
Technology integration strategies require a combination of **hardware,** or equipment, and **software,** or programs, written to perform various functions. Even today's **mobile devices,** or portable, handheld computer equipment, such as cell phones or iPads, have this hardware/software combination. Sometimes software and data must be stored outside of the hardware using flash drives, CDs, or various types of DVDs. These are thought of as **storage media,** rather than hardware. However, a growing trend is toward using online storage, referred to as **cloud computing,** which is using software stored outside one's own computer on servers that are accessed through the Internet.

Technology Facilities: Hardware and Configurations for Teaching

Figure 1.2 gives a visual overview of the six types of technology hardware in common use in today's classrooms. These include:

- **Microcomputers**—Though technologies are becoming increasingly smaller and more mobile, microcomputers, sometimes referred to as desktop computers, remain a mainstay of classroom computing. Portable devices, such as tablet and notebook computers and **netbooks**, or handheld computers that are like notebooks but with more limited features, have also become popular.
- **Handheld technologies**—Even smaller, multi-purpose devices, such as cell phones, ebooks, and "smart" pens, make it easier for teachers and students to view, communicate, and share information, regardless of location.
- **Display technologies**—These devices support whole-class or large-group demonstrations of information from a computer. They are sometimes used in combination with devices such as **clickers** (a.k.a., **student response systems**), which are wireless devices used for interactive polling of student answers to teacher questions in face-to-face classes.
- **Imaging technologies**—To make teaching and learning more visual, these devices allow the development and use of images ranging from still photos to full-motion videos.
- **Peripherals**—These are input devices, such as keyboards and mice (to get information and requests into the computer for processing), and output devices, such as printers and synthesizers (to see or hear the results of the processing), that make microcomputers more functional.
- **External storage**—While most storage is either inside the computer itself or on storage media, sometimes a device is needed to hold large files that won't fit easily on storage media or to allow a backup copy of all files inside the computer.

FIGURE 1.2 The Teacher's Hardware Toolbox



As Table 1.2 shows, digital equipment can be arranged or configured in various ways, each of which is suited to supporting specific types of integration strategies. Configurations include laboratories of networked computers, mobile workstations and labs, and computer arrangements in classrooms.

Types of Software Applications in Schools

Schools carry out many types of activities in addition to teaching, and software has been designed to support each of these. Software to support educational technology applications in school settings include:

- **Instructional**—Programs designed to teach skills or information through demonstrations, examples, explanations, or problem solving. Examples are tutorials, drill-and-practice programs, and simulations.

- » **Productivity**—Programs designed to help teachers and students plan, develop materials, communicate, and keep records. These include word processing, spreadsheet, database, and email programs, as well as a variety of other materials generators and data collection/analysis, graphics, and research and reference tools.
- » **Administrative**—Programs that administrators at school, state, and district levels use to support record keeping and exchanges of information among various agencies. These include student records and payroll systems.

Technology integration strategies described in this textbook focus primarily on instructional and productivity applications that teachers implement. However, some administrative applications that both teachers and administrators use are also described.

TODAY'S EDUCATIONAL TECHNOLOGY ISSUES: CONDITIONS THAT SHAPE PRACTICE

One reason that teaching today is so challenging is that it occurs in an environment that mirrors—and sometimes magnifies—some of society's most profound and problematic issues. Adding digital technologies to this mix continues to make the situation even more complex. Yet, to integrate technology successfully into their teaching, educators must recognize and be prepared to work in this environment with all of its subtleties and complexities. Some of today's important issues and their implications for technological trends in education are described in the following sections.

Table 1.2 Types of Technology Facilities and How They Are Used

Types of Facilities	Uses	Benefits	Limitations/Problems
Laboratories (usually 20–30 networked computers)			
All labs		Centralized resources are easier to maintain and secure; networking software can monitor individual performance in groups.	Need permanent staff to supervise and maintain resources. Students must leave their classrooms to use them.
Special-purpose labs	• Programming or technical courses • Technology education/vocational courses (e.g., with CAD, robotics, desktop publishing stations) • MIDI music labs • Labs dedicated to content area(s) (e.g., mathematics/science, foreign languages) • For use by Chapter or Title III students • Multimedia production work • Teacher work labs	Permanent setups of group resources specific to the needs of certain content areas or types of students.	Usually exclude groups who do not meet special purpose. Isolate resources.
General-use computer labs (open to all school groups)	Student productivity tasks (e.g., word processing, multimedia production); class demonstrations; student project work	Accommodate varied uses by different groups.	Difficult to schedule specific uses. Usually available to only one class at a time.
Library/media center labs	Same as for general-use labs	Same as for general-use labs, but permanent staff are already present. Ready access to all materials to promote integration of computer and noncomputer resources.	Same as for general-use labs. Staff members need special training. Classes cannot usually do production or group work that might bother other users of the library/media center.

Types of Facilities	Uses	Benefits	Limitations/Problems
Mobile Computers (a.k.a. computers on wheels or COWs)			
Mobile workstations	Demonstrations, short-term uses	Stretch resources by sharing them among many users; supply on-demand access.	Moving equipment can cause breakage and other maintenance problems. Sometimes difficult to get through doors or up stairs. Can increase security problems.
Mobile labs (complete set of computers, usually 15–30 handhelds or laptops on carts)	Individual student or teacher production and data-gathering tasks, teacher assessment tasks (e.g., with handheld devices)	Same as for mobile work-stations, but serve more students at one time.	Same as for mobile workstations.
Classroom Computers			
Classroom workstations (usually 2–5 computers with a printer)	Learning stations with individual tutoring and drills; whole-class demonstrations; Internet research and production tasks for cooperative learning groups	Easily accessible to teachers and students.	No immediate technical assistance available to teachers. Only part of class can use at one time.
Stand-alone classroom computer (one computer, often connected by network to school server)	Whole-class demonstrations; teacher email; small group tasks	Same as for classroom workstations.	Same as for classroom workstations.

Issues are discussed in four areas: societal, educational, cultural/equity, and legal/ethical. Major studies, publications, and websites with information on each of these issues are listed in Table 1.3, along with recommendations on appropriate teacher responses and responsibilities.

Social Issues

Technology uses have a way of both responding to societal needs and problems and creating a new set of issues with society-wide implications. Social issues such as quality of life concerns, fears about technology overuses and misuses, risks associated with social networking, and problems due to malicious attacks on computers shape the climate for educational use. School systems are rapidly recognizing that these problems are too pervasive and have too much potential financial and personal impact to address on a piecemeal basis. Rather, these issues must become part of required curriculum for students and professional development for teachers. A planned, ongoing education program will be needed to make teachers and students aware of these concerns so all may use technologies in ways that limit possible negative impact.

Quality of life concerns. Some critics say that ubiquitous technology is a threat to personal privacy. Online companies track user characteristics and preferences based on the choices they make, frequently installing **spyware,** or software that is placed on a computer without the user's knowledge for the purpose of gathering information about them (usually to sell to marketing firms). Technologies such as **radio frequency identification (RFID),** an electronic monitoring system that can track the location of the chip's wearer, create worries about privacy. First introduced in department stores to monitor inventory and prevent theft of goods, RFID is being used in some schools to track student attendance and increase school security. Still others say that computer use poses potential health hazards, such as hearing loss from headphone use or eye strain from gazing too long at computer screens or small cell phone displays. Like all citizens of the Information Society, educators are concerned about these privacy and health issues and school administrations continue to track research about their possible effects.

Fears about technology overuse. As technology use has increased among young people, fears about "Internet addiction" and other issues of overuse have arisen. Young people are avid multitaskers, frequently using several technologies at the same time while studying or driving. However, studies have shown that accuracy and safety usually suffer when people try to attend to more than one task at a time. Other

Table 1.3 Issues That Shape the Environment for Using Technology and Teacher Responses and Responsibilities

Description	Information Sources	Critical Teacher Responses
Social Issues		
Quality of life concerns	*Wall Street Journal* study on digital privacy: Search for "The Web's New Gold Mine: Your Secrets" at http://online.wsj.com	Teach students how to keep their personal information private and protected
Fears about technology overuses	Search for *The New Atlantis* article, "The Myth of Multitasking" at http://www.thenewatlantis.com Search for the *Science* study, "Multitasking Splits the Brain" at http://news.sciencemag.org Search for *New York Times* series, "Your Brain on Computers" at http://www.nytimes.com	Read recent studies to keep updated on the social impact of computer use Teach the importance of a balance of technology-based and other activities Emphasize the importance of focused (non-multitasked) work
Fears about technology misuses	Search for *eSchool News* article, "Survey Reveals Disconnect in Online Safety Education" at http://www.eschoolnews.com Search for *eSchool News* report, "Teens Using 'Digital Drugs' to Get High" at http://www.eschoolnews.com	Teach students about dangers of unwise text messages (e.g., sexting) Find and discuss examples of unwise postings with negative consequences
Risks of online social networking	Search for *Education Week* blog post, "Back-to-School Social-Networking Policies" at http://www.edweek.org Search for sample "networking policy" at http://www.leeschools.net See Cyberbullying Research Center (with updates on Cyberbullying laws) at http://www.cyberbullying.us	Know your own district's social networking policies; if there is none, advocate for creating one Keep vigilant for instances of online bullying
Problems due to malware, viruses, spam, and other malicious actions	Search for *New Scientist* article, "Introduction: Computer Viruses" at http://www.newscientist.com Search for article, "The Common Types of Computer Viruses" at http://www.spamlaws.com	Frequently update each computer's virus protection software Teach students how to avoid virus attacks Demonstrate what a phishing attempt looks like and how to avoid it
Educational Issues		
Lack of technology funding	Federal funding opportunities: http://www2.ed.gov/fund/landing.jhtml Educational technology funding opportunities: http://www.technologygrantnews.com Search for *Education Week* article, "Schools Combine Netbooks, Open Source" on how to make computing more affordable at http://www.edweek.org	Stay in touch with local and national funding opportunities Look for ways to fund technology projects Advocate for funds for purchases tied to specific educational improvements Research low-cost and open-source computing options (such as those in this text)
Teacher and student accountability for quality and progress	NCLB background and updates: http://www.nochildleftbehind.com	Keep up to date on latest federal requirements
Debate over best practices with technologies	Partnership for 21st Century Skills website: http://www.p21.org Project Tomorrow surveys on technology uses in teaching: http://www.tomorrow.org	Keep up-to-date on best practices for teaching 21st Century Skills

Description	Information Sources	Critical Teacher Responses
Reliance on distance education	Keeping Pace with K–12 Online Learning: http://www.kpk12.com	Demonstrate and model online learning methods and resources
Cultural/Equity Issues		
The Digital Divide	Read reports on mobile access and social media at the *Pew Internet and American Life Project* site at http://pewinternet.org Search for the report, "Scaling the Digital Divide: Home Computer Technology and Student Achievement" at http://www.urban.org	Read latest reports on how to bridge the Digital Divide at http://www.digitaldivide.net and others Be aware of and use classroom practices that encourage and support technology use by girls and minority students
Racial and gender equity	Read studies of STEM use and best practices for STEM education with minority students at Bayer Facts of Science Education site at http://bayerfactsofscience.online-pressroom.com	Use best practices to encourage female and minority participation in STEM courses and careers
Students with special needs	Assistive technologies website: http://www.closingthegap.com Universal Design for Learning website: http://www.cast.org	Keep updated on technologies that can be of use to solve problems for students with disabilities Use sites that show latest adaptive technologies
Legal/Ethical Issues		
Hacking	Search for *Education Week* article, "Tech-Savvy Students Hack Into School Computers" at http://www.edweek.org	Take steps to prevent "cyber mischief": require network logins, educate students about digital citizenship, set consistent consequences for violators, enable firewalls and content filters
Safety issues	Search for "Model Acceptable Use Policy" (AUP) at http://www.justice.gov Review FEMA's online safety rules for kids at http://www.fema.gov/kids/on_safety.htm See the "Online Safety Guide" at http://kids.getnetwise.org	Know your school or district AUP; if there is none, advocate for creating one Teach all students AUP and safe online procedures
The new plagiarism and academic dishonesty	Search for *New York Times* article, "Plagiarism Lines Blur for Students in Digital Age" at http://www.nytimes.com Search for Library of Congress statement on 2010 changes to U.S. copyright law ("Statement of the Librarian of Congress Relating to Section 1201 Rulemaking") at http://www.copyright.gov Search for article, "Does Your Instructor Know It's You? Issues in Verifying Online Student Identities" at http://www.distance-education.org	Teach students about fair use and how to avoid unintentional plagiarism
Illegal downloads/software piracy	Search for Business Software Alliance Report, "Software Piracy Rate Up 2% in 2009, Study Finds" at http://www.networkworld.com Search for article, "Who Music Theft Hurts" with Piracy Statistics from the Recording Industry Association of America (RIAA) at http://www.riaa.com	Educate students about software/music piracy laws and repercussions for breaking them

Hot Topic Debate

SOCIAL NETWORKING AS DISTRACTION?

Take a position for or against (based either on your own position or one assigned to you) on the following controversial statement. Discuss it in class or on an online discussion board, blog, or wiki, as assigned by your instructor. When the discussion is complete, write a summary of the main pros and cons that you and your classmates have stated, and put the summary document in your teacher portfolio.

In his essay "The End of Human Specialness," Lanier (2010), author of *You Are Not a Gadget*, said, "A post-Facebook generation is appearing, and its members are questioning the legacy of their predecessors. Recently, when I asked students not to tweet or blog during a lecture, they stood and cheered" (p. 7). These authors are among those who view social networking as a distraction to learning, rather than a resource to support learning. What examples and research results (not opinions) could you use to either support or refute this position?

studies have found that very high use of computers correlates with health issues such as higher body mass and lowered physical fitness. See one expert's opinion on technology overuse in this chapter's Hot Topic Debate.

Fears about technology misuses. Young people are often unaware that images they send on handheld devices are not private. Consequently, they may not hesitate to send out explicit photos or text messages on their cell phones or through the Internet, a practice called **sexting**. Other reports of various kinds of misbehaviors tend to make a big splash in the media, but it is unclear how much of a threat they pose. The practices of **i-dosing,** or going to sites that allegedly induce a state of ecstasy from listening to music, is an unlikely, but still troubling, phenomenon.

Risks of online social networking. For many students, use of social networking takes so much of their time that it could prove a distraction to schoolwork (Goodman, 2011). In addition, social networking has been shown to expose young people to **cyberporn,** or pornographic Internet sites, and online predators. Mitchell, Wolak, and Finkelhore (2007), a team of researchers who have been tracking these trends for the last decade, found that 42% of Internet users aged 10 to 17 had been exposed to online porn, and two-thirds of the exposure had been unintended. Levy (2010) reported a study showing that about a third of British children had seen these sites by the time they were 10 years old. Students are often unaware that colleges and universities look at students' social networking sites to gain a better picture of their background. Teachers who have their own social networking sites (e.g., Facebook) have encountered criticism for ill-advised personal posts and contacts with students. **Cyberbullying,** or online harassment in social networks, is a growing concern that mirrors similar bullying on school campuses. A study of over 1,450 adolescents aged 12 to 17 by Juvonen and Gross (2008) found that 77% of adolescents reported at least one incident of school bullying, and 72% reported having been cyberbullied. Online bullying has as many negative consequences as in-person bullying. The Cyberbullying Center's (http://www.cyberbullying.us) reports current statistics on its website that, while lower than those found by Juvonen and Gross, indicate that cyberbullying is an ongoing problem.

Problems due to malware, spam, and other malicious actions. The problems with computer malware and spam that emerged with the microcomputer era have grown into major drains on both time and finances in the Internet and ubiquitous-computing eras. **Malware,** short for malicious software, is any software specifically designed to damage, destroy, disrupt operations, or spy on the operation of computers. **Viruses,** a type of malware, are programs written specifically to do harm or mischief to programs, data, and/or hardware, and include **logic bombs, worms,** and **Trojan horses. Spyware** is malware that secretly gathers information stored on a person's computer. This information is usually gathered for marketing purposes, but spyware can also be designed to gather addresses, passwords, and credit card numbers to use for identity theft. **Spam** is any unsolicited email message or website posting, usually sent for the purpose of advertising products or services or soliciting funds. These attacks and messages come with such frequency that they interfere with computer work. Schools and colleges have dedicated considerable resources to blocking them. To address these issues, many educational organizations have turned to outsourcing their email to a provider such as Google. Computer users sometimes respond unwittingly to **phishing** attempts, or emails that falsely claim to be a legitimate business in order to glean private information to be used for identity theft. Sometimes these attempts turn computers into **zombies,** or computers implanted with a program that puts it under the control of someone else without the knowledge of the computer user.

Educational Issues

Trends in the educational system are intertwined with trends in technology and society. Four kinds of educational issues have special implications for the ways technology is used in teaching and learning:

Lack of technology funding. Recent economic downturns in the U.S. economy have meant decreased education funding, which also means fewer funds available for technology hardware, software, and training. This downturn comes at a time when technology expenses are on the rise. Advocates of **one-to-one computing,** or allocating a school computer for each student, are gaining attention, and schools are faced with increased costs due to replacing their aging computer systems. However, some educators are unwilling to advocate for technology funding, claiming that teaching/learning benefits have not been clearly established and other programs that are being cut (e.g., music, arts) are just as important. On the other hand, technology advocates point out strategies such as open-source options that make technology use more equivalent to costs of other instructional materials.

Teacher and student accountability for quality and progress. The accountability requirements of the No Child Left Behind (NCLB) Act of 2001 was the beginning of federal pressure on schools to meet "**Adequate Yearly Progress (AYP),**" that is, progress in meeting criteria that demonstrate they are effective schools. All content areas and states have skill standards that students must meet to pass courses and to get degrees and certification. High-stakes tests on content standards are used to determine successful AYP. Though NCLB was modified when the Elementary and Secondary Education Act (ESEA) was re-authorized, the accountability movement remains strong and drives a trend toward using technology in ways that help teachers and students pass tests and meet required standards, rather than to support more innovative teaching strategies.

Debate over best practices with technologies. Educators disagree on the proper roles of traditional, teacher-directed methods versus student-led, inquiry-based methods. Long-used and well-validated teacher-directed uses of technology have been shown to be effective for addressing content standards, but many educators see them as passé. Inquiry-based, constructivist methods are considered more modern and innovative, but it is less clear how they address standards required to demonstrate teacher and student accountability. The 21st Century Standards (discussed later in this chapter) may help inform this debate. These standards focus on skills in critical thinking and problem solving that will require non-traditional technology-based strategies. The proposed Common Core Standards (http://www.corestandards.org), a set of content skills that would be common to all states, though controversial, may also play a part in this discussion.

Reliance on distance education. Increasing numbers of virtual K–12 courses are being offered, and virtual high schools are becoming commonplace in U.S. education. This means that students could have increased access to high-quality courses and degrees. However, virtual learning takes special skills not all students have, and dropout rates from distance courses are higher than rates for physical schools, which could further widen the Digital Divide. Schools are seeking ways to prepare students to take advantage of this new access. Recognizing that learning at a distance is rapidly becoming commonplace in higher education, some states, including Michigan, Florida, and Alabama, and some school districts, such as Putnam County, Tennessee, have made completing a distance course a high school graduation requirement.

Cultural and Equity Issues

As Molnar pointed out in his landmark 1978 article, "The Next Great Crisis in American Education: Computer Literacy," the power of technology is a two-edged sword, especially for education. While it presents obvious potential for changing education and empowering teachers and students, technology may also further divide members of our society along socioeconomic, ethnic, and cultural lines and widen the gender gap. Teachers will lead the struggle to make sure technology use promotes, rather than conflicts with, the goals of a democratic society.

The Digital Divide. A phrase coined by Lloyd Morrisett (Hoffman & Novak, 1998), former president of the Markle Foundation, the **Digital Divide** originally referred to a discrepancy in access to technology resources among

ROBL2258_CH01.indd 17 11/18/11 4:21 PM

socioeconomic groups. The single greatest factor determining access to technology is economic status, although race and gender may also play a role, depending on the type of technology. Recent studies find that while children from all income levels have greatly increased their Internet use and mobile technologies have provided access to many more young people than ever before, the Digital Divide has taken on a new and more subtle impact. While low-income and minority students have more access to technologies, education in how to take advantage of these technologies is still primarily available to those with economic advantages. A recent study by Vigdor and Ladd (2010) confirms that simply providing access to home computers can actually be associated with decreased achievement, since unmonitored children tend to use them primarily in noneducational activities. Students need access accompanied by systematic, focused instruction in how to make best use of these resources.

Racial and gender equity. Technology use remains dominated by males and certain ethnic groups. Studies show that when compared with males and whites, females, African Americans, and Hispanic minorities use computers less and enter careers in math, science, and technology areas at lower rates. Many educators believe these two findings are correlated: Lower use of technology leads to lower entrance into technical careers. Even where computers are available in schools, there tends to be unequal access to certain kinds of activities. For example, children in Title I programs may have access to computers, but they use them mainly for remedial work rather than for email, multimedia production, and other personal empowerment activities.

Students with special needs. Devices and methods are available to help students compensate for their physical and mental deficits and allow them equal access to technology and learning opportunities. However, technological interventions that could help students with special needs are difficult to purchase and implement and often go unused. Parents clamor for the technology resources guaranteed their children by federal laws, but schools often claim insufficient funding to address these special needs.

Legal and Ethical Issues

In many ways, technology users represent society in a microcosm. The legal and ethical issues educators face reflect those of the larger society. The five major types of ethical and legal issues, discussed next, have a major impact on how technology activities are implemented.

Hacking. When people use online systems to access the personal data of students in order to accomplish identity theft and commit other malicious acts, they are called **hackers,** and the actions they take are called **hacking.** To combat these problems, schools are forced to install **firewalls,** software that blocks unauthorized access to classroom computers, and to spend larger portions of technology funds each year on preventing and cleaning up after illegal activities. They must also constantly educate teachers and students on strategies to prevent these attacks.

ADAPTING FOR SPECIAL NEEDS

Assistive Technologies and Universal Design Resources

As a result of the emphasis placed by the No Child Left Behind Act of 2001 and the reauthorized Elementary and Secondary Education Act on reducing the historical achievement gap for students such as those with disabilities, a critical issue for teachers and administrators is: what role can technology play in supporting struggling learners? One way that technology offers access and engagement for these students is through assistive technologies, which are specialized products that level the playing field by overcoming an impairment or deficit to make it possible to be successful and independent. To learn more about what assistive technology looks like and how it can be used, visit: *Encyclopedia of Assistive Technology* (http://www.at-video-tutorials.com).

In recent years, the notion of using technology to support academic performance has expanded from assistive technology for some individuals to universal design for learning (UDL). UDL interventions seek to understand the needs of diverse learners such that supports are provided to all students. UDL was identified as a key component in the National Education Technology Plan 2010 (http://www.ed.gov/technology/netp-2010).

Contributed by Dave Edyburn

Safety issues. As students spend more time in online environments—both educational and non-educational—studies show a high incidence of attempts by online predators to contact students, and objectionable material is readily available and easy to access. To address these concerns, schools are requiring students/parents to sign an **Acceptable Use Policy (AUP)** that outlines appropriate use of school technologies for students and educators and putting procedures in place to safeguard access to students' personal information. Schools have also been put on notice to supervise carefully all student use of the Internet and to install filtering software to prevent access to objectionable materials.

The new plagiarism and academic dishonesty. Online availability of full-text publications is increasing, and distance courses are posting more materials in online course management systems. Greater online access to full-text documents on the Internet has resulted in increased incidents of students using materials they find online as their own, a practice often referred to as **cybercheating** or online cheating. Sites have emerged to help teachers catch plagiarizers, and the number of educational organizations and teachers using them is increasing. Teachers are also trying to structure assignments that make this kind of cheating more difficult. However, the lines between what is legal and illegal are also becoming blurry. To make sure they comply with copyright laws, schools are making teachers and students aware of policies about copyright, AUP, and guidelines for fair use of published materials.

The rise in online education has also caused educators to confront the issue of student identities and academic fraud: How can they confirm that students signed up for an online course are actually the ones doing the work of the course (Williamson, 2010)? Some organizations have moved to remote proctoring systems to monitor students visually, while others have students come into a physical location to take required exams.

Illegal downloads/software piracy. An increasing number of sites offer ways to download copies of software or other media without paying for them, a practice known as **software piracy,** and software and media companies are prosecuting more offenders. The 2009 study by the Business Software Alliance (**http://portal.bsa.org/globalpiracy2009/index.html**) found that software piracy was at a rate of 43% and results in $51 billion in lost revenue each year. Despite the ease of copying or downloading free materials, teachers are tasked with modeling and teaching ethical behaviors with respect to software and media.

The most important of these issues in terms of their impact in shaping what we can and must do with technology in education are summarized in the Top Ten feature. What we are able to do to apply the power of technology to enhance education will be shaped primarily by how we are able to respond to these major issues.

Inform students about their school's Acceptable Use Policies (AUPs) both to educate and protect them.
Photo by W. Wiencke.

TODAY'S EDUCATIONAL TECHNOLOGY SKILLS: STANDARDS AND ASSESSMENTS

Clearly, 21st-century educators will have to deal with issues and situations that their predecessors could not even have imagined. New technology tools also mean new and different ways of accessing and processing information needed for teaching and learning. Both teachers and students must have the skills and knowledge that will prepare them to meet these new challenges and use these new and powerful strategies. Three sets of skills have been created to guide them. Two created and used primarily in the United States are the National Educational Technology Standards (NETS) created by ISTE, and the 21st Century Skills created by the Partnership for 21st Century Skills (P21). A third set that also guides teacher skills but has a worldwide focus is the Information and Communications Technology (ICT) Competency Standards for Teachers, created by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Links to all three sets are shown in Table 1.4 (p. 21).

NETS for Teachers, Students, and Administrators

ISTE is a technology professional organization described earlier in this chapter and has developed National Educational Technology Standards (NETS) for students, teachers, and school administrators. ISTE NETS for Teachers have become the benchmark for technology infusion in teacher education programs. It is important to note the relationship between the NETS for Teachers and NETS for Students, as shown in the front of this book. NETS for Students are considered to be the basic skills that students—and their teachers—should meet. NETS for Teachers, which

TOP TEN

Issues Shaping Today's Technology Uses in Education

SOURCE	TRACK	SELECTION
Accountability and the standards movement	**1**	Educators want to know (a) how technology can help students meet required curriculum standards and (b) what role technology skills should play in children's education.
Funding for educational technology	**2**	As technology costs grow and education funds wane, policy makers ask, "How can we justify spending scarce education dollars on technology?"
The Digital Divide	**3**	Since technology access differs between wealthier and poorer schools, people want to know if technology is deepening the economic chasm between rich and poor.
Fears about technology misuses	**4**	Misuses of devices and social media (e.g., sexting and cyberbullying) have caused numerous social and legal problems. Young people have to be educated in how to address these misuses.
The role of distance education	**5**	Virtual schools are springing up around the country. Parents wonder: (a) Can all students succeed in online environments? (b) Will students learn as much as in face-to-face classrooms? (c) How will funding for virtual schools affect funding for traditional schools?
Privacy and safety	**6**	As more student data go online and students spend more time on the Internet, measures have to be put in place to limit access to personal data and to protect students from online predators.
Malware, viruses, spam, and hacking	**7**	The online community is seeing an unprecedented number of problems related to illegal entries into networks. Schools, like all organizations, are forced to spend precious funds on measures to protect themselves.
Online plagiarism	**8**	Students have easy access to papers and projects they can turn in as their own work. Teachers have to be on the alert for plagiarism, use online sources to check suspicious work, and structure assignments to make cheating difficult.
Racial and gender equity	**9**	Science, technology, and engineering careers remain dominated by males and certain ethnic groups; some educators say more student involvement in technology at earlier levels could change this picture.
21st century technology skills	**10**	Society's increasing dependence on technology to communicate information means that students must learn the skills to use information technologies effectively.

Table 1.4 Links to Today's Educational Technology Skill Standards

ISTE National Educational Technology Standards (NETS) for Teachers, Students, and Administrators	http://www.iste.org/AM/Template.cfm?Section=NETS
P21 21st Century Skills (for students)	http://www.p21.org
ICT Competency Standards for Teachers (for teachers)	http://cst.unesco-ci.org/sites/projects/cst/default.aspx

assume that teachers have attained the student NETS, focus on teaching skills that use technologies.

21st Century Skills for Students and Teachers

P21, as its website says, is "a unique public-private organization formed in 2002 to create a successful model of learning for this millennium that incorporates 21st century skills into our system of education." P21 partners include the National Education Association and a group of large companies, including Apple Computer, Inc. and the Dell Computer Corporation. Figure 1.3 is an image from the P21 website that shows three overarching categories of student outcomes (Life and Career Skills; Learning and Innovation Skills; and Information, Media, and Technology Skills) and illustrates the support systems students and teachers will need to achieve these skills (Standards and Assessments, Curriculum and Instruction, Professional Development, and Learning Environments). In addition to a listing of specific "knowledge, skills, and expertise students should master to succeed in work and life in the 21st century," P21 has identified a set of essential core subjects (English, reading, or language arts, world languages, arts, mathematics, economics, science, geography, history, and government/civics), as well as interdisciplinary themes that should be interwoven through these subjects. These themes, which also have skills listed under each one, include: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; and environmental literacy.

In Figure 1.3, the skill areas that fall under each of the three overarching categories are shown in the boxes that surround the "rainbow." The P21 website also provides skills maps for each content area that list specific learning activities for each of the P21 competencies.

The ICT Competency Framework for Teachers

UNESCO personnel collaborated with industry partners Cisco, Intel, ISTE, and Microsoft to create the **information and communication technology (ICT)** framework, which focuses on skills that teachers require to bring about three different levels of human capacity development: technology literacy, knowledge deepening, and knowledge creation. ICT is a term often used in place of the terms *instructional technology* and *educational technology*, especially outside the United States.

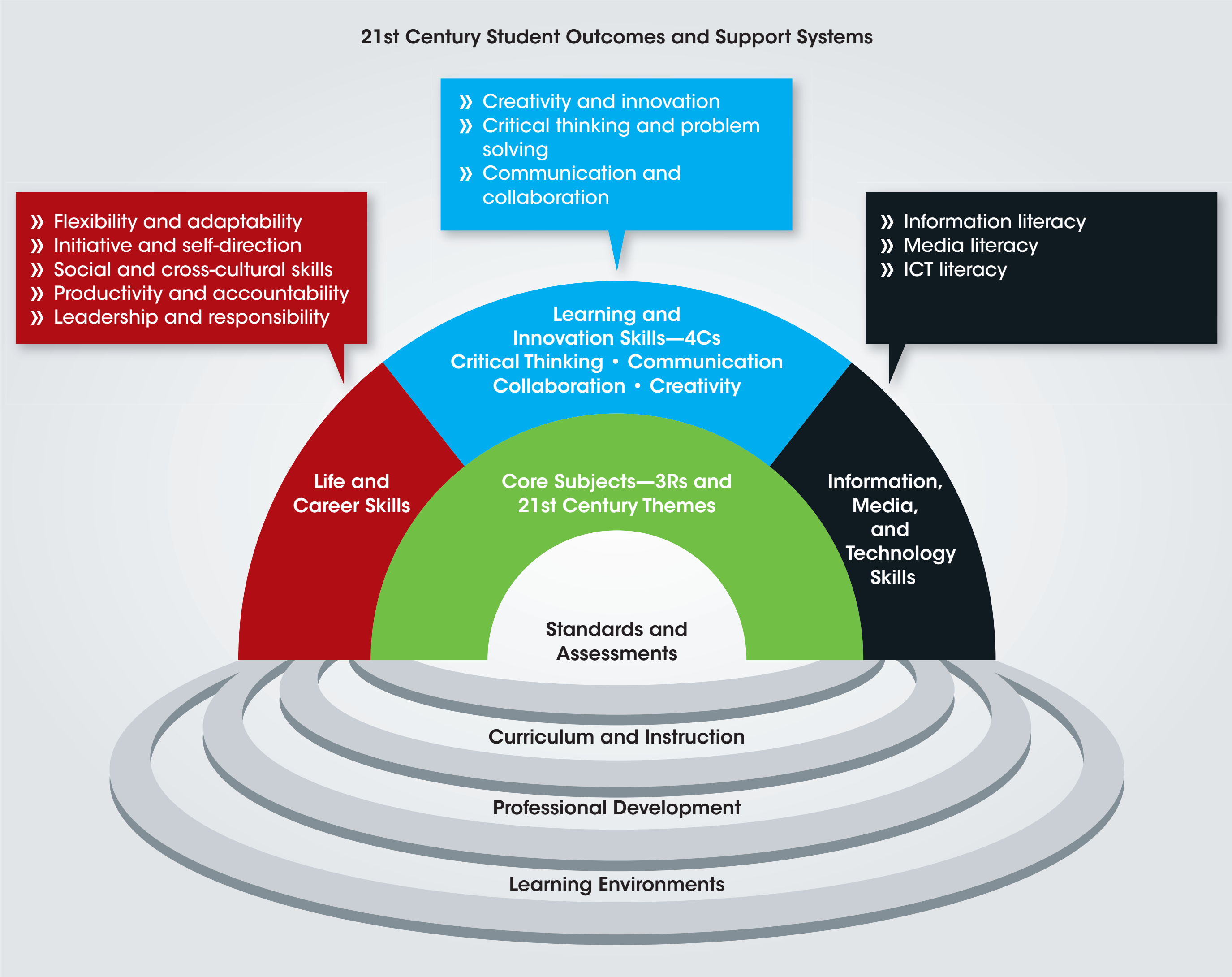
- **Technology literacy**—Needed to "prepare learners, citizens, and a workforce that is capable of taking up new technologies so as to support social development and economic productivity."
- **Knowledge deepening**—Increases "the ability of students, citizens, and the workforce to add value to society and the economy by applying the knowledge of school subjects to solve complex, high priority problems encountered in real world situations of work, society, and life."
- **Knowledge creation**—Intended "to increase productivity by creating students, citizens, and a workforce that is continually engaged in and benefits from knowledge creation and innovation and life-long learning."

UNESCO has Teacher Competency Standards Modules for each of these levels. Each module consists of curricular goals and teacher skills in six different areas: policy, curriculum and assessment, pedagogy, ICT, organization and administration, and teacher professional development.

Demonstrating Technology Skills: Portfolio Options

Many teacher preparation programs require their candidates to develop a teaching **portfolio**, a collection of their work products from courses they take, to demonstrate their achievement of required skills as they go through the program. Portfolios are a collection of the student's work products over time, arranged so that they and others can see how their skills have developed and progressed. They also include criteria for selecting and judging content. The portfolio concept originated in higher education with colleges of arts, music, and architecture, areas in which work could not be measured well through traditional tests. Instead of final exams, these students had to have a professional portfolio

FIGURE 1.3 The P21 Skill Framework and Skill Areas under Each Major Category



Source: Reprinted by permission of the Partnership for 21st Century Skills.

when they graduated to demonstrate their level of accomplishment in their field.

In addition to showing their own technology development, teachers may want to have their students demonstrate their skills with a portfolio. For today's technology-integrated curriculum, which often calls for multimedia work products, many teachers are turning to student **electronic portfolios**, or a collection of work in a website or multimedia product, as the assessment strategy of choice. Although older students could decide on their own portfolio format, teachers usually provide the portfolio structure and tell students how to fill in the content. Teachers can choose from several kinds of resources for their own and their students' portfolios. See Open-Source Options for free versions of the following materials:

"Ready-made" portfolio software packages. These packages provide a structure to which teachers can add content instead of creating their own format. They include: Grady Profile by Auerbach and Teacher's Portfolio at Super School Software. A popular online portfolio site is Livetext at http://www.livetext.com. These systems usually are built on database software, with locations for attaching files of written and visual products.

Adobe Acrobat Professional. To store and display documents (with or without graphics), teachers can use *Adobe Acrobat Professional (Pro)* to create electronic versions of pages. PDFs are essentially "pictures of pages" and are easy to store and share with others by downloading the free *Acrobat Reader* from http://get.adobe.com/reader. However, *Adobe Acrobat Pro* also has features that allows files that were created in different formats and applications (e.g., *Word* documents, email messages, spreadsheets, and *PowerPoint* presentations) to be combined in one portfolio file.

Free open source OPTIONS for Electronic Portfolios

TYPES OF PORTFOLIO DEVELOPMENT MATERIALS	FREE SOURCES
Ready-made portfolio software packages	Mahara e-Portfolios: http://mahara.org Sakai's Open Source e-Portfolio System: http://sakaiproject.org
Multimedia authoring software	*Sophie*: http://blogs.oreilly.com/digitalmedia/ 2007/02/ open source-ebook-sophie.html
Relational databases	*PostgreSQL*: http://www.postgresql.org *Firebird*: http://www.firebirdsql.org
Free websites with templates	Google Sites: http://www.google.com/sites Steps for creating a Google Sites portfolio: http://www.learnnc.org/lp/pages/6437 Listing of other free sites at Internet4Classrooms: http://www.internet4classrooms.com/links_grades _kindergarten_12/web_page_hosting_teacher_tools.htm
Video editors	*Open Movie Editor*: http://www.openmovieeditor.org

Multimedia authoring software. Early multimedia programs such as *HyperStudio* are still being used, but some teachers now structure portfolios with packages such as Microsoft *PowerPoint*, Apple *Keynote*, Adobe *Director*, Travantis *Lectora*, or *MediaWorks*. All these packages allow for advanced, sophisticated video and audio presentations and are, therefore, more complex to learn than others discussed here.

Databases. Relational database software, such as *File-Maker Pro*, are helpful to teachers who must keep track of many students' work. They offer teachers the advantage of cataloguing work and creating profiles of achievement across groups of students.

Websites. Portfolios can be posted on the Internet, where they can be more easily shared with others. Like multimedia packages, these portfolios can offer sophisticated video and audio presentations. Adobe's ***Creative Suite*** and ***Fireworks*** are popular web-page development packages.

Video. Although analog video offered only a low-cost, linear format, today's digital video offers much more flexible, interactive formats for displaying portfolio elements. For a review of ten different movie-making software packages, see http://video-editing-software-review.toptenreviews.com.

Figure 1.4 shows a suggested sequence to follow in creating an electronic portfolio. Also see Barrett's collection of portfolio resources at http://electronicportfolios.com for more advice on portfolio development.

TODAY'S EDUCATIONAL TECHNOLOGY APPLICATION: DEVELOPING A SOUND RATIONALE

The history of educational technology teaches us the importance of the "Why use technology?" question. Also, two current conditions in education and society make it essential that teachers and schools are able to state a clear and compelling case for using technology in education. Both these conditions relate to the expense of using technology.

First, the process of integrating technology effectively into education requires substantial, ongoing investments in technology infrastructure and teacher training. Educators and policy makers need to offer a solid rationale for why

FIGURE 1.4 Electronic Portfolios: How to Develop Them

DETERMINE PORTFOLIO REQUIREMENTS

Find out products required, medium to use, and criteria to meet. See rubric for evaluating portfolio quality: http://www.uwstout.edu/static/art/artedportfolios/evaluating/portevaluatiorubric.html

↓

CREATE THE STRUCTURE

Set up the portfolio structure on the medium (e.g., web, PowerPoint, Adobe Acrobat) you have chosen

↓

ADD AND LINK COMPONENTS

Create media and software products to demonstrate technology integration skills; add to portfolio by required deadlines

↕

MONITOR THE COLLECTION; RECEIVE PERIODIC FEEDBACK

Review products with instructors; determine if requirements are being met

↕

REFLECT ON PRODUCTS; REVISE AS NEEDED

Add or revise components based on reflection and feedback

these funds are well spent. Second, the accountability movement begun by the NCLB Act of 2001 is predicted to dominate policy and drive funding for some time to come. Administrators want to see evidence that technology purchases help improve students' achievement, increase school attendance, or improve graduation rates. Developing a sound rationale for using technology in specific situations requires reviewing research findings and other evidence that technology is, indeed, helping to address some of education's most urgent needs and problems.

What Does Research on Technology in Education Tell Us?

Limitations of past research. Even though electronic technologies have been in use in education since the 1950s, research results have not drawn a clear line between technology use and impact on educational quality indicators required for AYP. Researchers such as Clark (1983, 1985, 1991, 1994) have openly criticized "computer-based effectiveness" research and **meta-analysis,** which is a statistical method designed by Glass (1976) to summarize results across studies and measure the size of the effect a "treatment," such as technology-based methods, has over and above traditional methods. Clark concluded that most such studies that have found a greater impact on achievement of one delivery method over the other did not control for factors such as different instructors, instructional methods, curriculum contents, or novelty. He famously said technologies make no more contribution to quality indicators than the truck that delivers the groceries does for nutrition. Though Kozma (1991, 1994) responded by asserting that research should look at technology not as an information delivery medium but as "the learner actively collaborating with the medium to construct knowledge" (1991, p. 179), policy makers still need evidence that this collaboration improves learning in measurable ways.

The beginning of one-to-one initiatives. Some of the most promising research results to date have come from the so-called one-to-one computing initiatives, sometimes known as laptop programs. These programs provide a **laptop,** that is, a small portable personal computer, or other mobile computing device to every student in a given grade level or school and measure the impact on achievement, dropout rate, attendance, and other factors. Maine led this effort with a statewide program for middle school students in 2001 after a successful pilot project. After three years, Gulek and Demirtas (2005) reported that middle school students who had used laptops showed significantly higher achievement than their non-laptop cohorts in nearly all measures.

Research results from one-to-one initiatives. Other one-to-one initiatives followed suit, but with varying results. Bebell and O'Dwyer (2010) edited a group of articles reporting the results of four other one-to-one initiatives (Bebell & Kay, 2010; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Suhr, Hernandez, Grimes, & Warschauer, 2010; Weston & Bain, 2010). These reports show that each initiative had an impact on quality predictors, but the amount of impact varied according to factors such as how projects were implemented, teacher acceptance, and students' outside-school uses of the devices. Schools that provided peripherals such as projection systems along with the devices, offered continuing technical support and in-depth professional development, and had teachers who were willing to try using teaching methods had more impact than schools that had few or none of these factors. One study found that students who used devices more outside the classroom also reflected significantly greater impact.

Results of Project RED (Revolutionizing Education), an initiative completed with funding from computing industries, including Intel, found similar results: one-to-one initiatives are improved quality indicators, but only if certain optimal conditions are in place. Overall, schools with one-to-one computing programs had "fewer discipline problems, lower dropout rates, and higher rates of college attendance than schools with a higher ratio of students to computers" (Devaney, 2010). In non–one-to-one comparison schools in the study, 69% reported that their students' achievement scores on high-stakes tests were on the rise. Schools with one-to-one computing programs had a slightly higher (70%) increase, but it was 85% in schools with one-to-one computing programs that "employed certain strategies for success, including electronic formative assessments on a regular basis and frequent collaboration of teachers in professional learning communities" (Devaney, 2010).

A Technology-Use Rationale Based on Problem Solving

As recent research shows, the case for using technology in teaching is one that must be made not just by isolating variables that make a difference, but by combining them. Practitioners have cited over the years a number of reasons for why we should integrate technology into teaching. These are described here in three different categories related to solving problems that limit learning, but it is when these contributions are combined that technology seems to make the greatest difference.

Problem 1: How to motivate and engage students?

Technologies, when properly implemented, can use the following strategies to address the problem of unmotivated students:

- **Gaining their attention**—Teachers say technology's visual and interactive qualities can direct students' attention toward learning tasks.
- **Supporting manual operations during high-level learning**—Students are more motivated to learn complex skills (e.g., writing compositions and solving algebraic equations) when technology tools help them do the low-level skills involved (e.g., making corrections to written drafts or doing arithmetic).
- **Illustrating real-world relevance through highly visual presentations**—When students can see that high-level math and science skills have real-life applications, it is no longer just "school work"; they are more willing to learn skills that have clear value to their future life and work.
- **Engaging students through production work**—Students who learn by creating their own products with technologies such as word processing, multimedia, and other technology products report higher engagement in learning and a greater sense of pride in their achievements.
- **Connecting students with audiences for their writing**—Educators say that students are much more motivated to write and do their best production work when they publish it on the web, since others outside the classroom will see their work.
- **Engaging learners through real-world situations and collaborations**—Students who see the application of what they are studying as authentic and part of the real world are motivated by the application to their daily lives.
- **Providing support for working cooperatively**—Although students can do small-group work without technology, teachers report that students are often more motivated to work cooperatively on hypermedia, database, and website production projects.

Problem 2: How to support students' learning needs?

The following are ways technologies can support students' learning activities by making their work more efficient and productive and by providing access to sources and ways of learning that they would not otherwise have:

- **Supporting effective skill practice**—When students need focused practice in order to comprehend and retain the skills they learn, software such as the drill-and-practice type offers the privacy, self-pacing, and immediate feedback that makes practice most effective.
- **Helping students visualize underlying concepts in unfamiliar or abstract topics**—Simulations and other interactive software tools have unique abilities to illustrate science and mathematics concepts. Highly abstract mathematical and scientific principles become clearer and easier to understand.
- **Letting students study systems in unique ways**—Students use tools such as spreadsheets and simulations to answer "what if" questions that they would not be able to do easily by hand or that would not be feasible at all without the benefits of technology.
- **Giving access to unique information sources and populations**—The Internet connects students with information, research, data, and expertise not available locally.
- **Supplying self-paced learning for accelerated students**—Self-directed students can learn on their own with software tutorials and/or distance learning materials. They can surge ahead of the class or tackle topics that the school does not offer.
- **Turning disabilities into capabilities**—Students with disabilities depend on technology to compensate for vision, hearing, and/or manual dexterity they need to read, interact in class, and do projects to show what they have learned.
- **Saving time on production tasks**—Software tools such as word processing, desktop publishing, and spreadsheets

allow quick and easy corrections to reports, presentations, budgets, and publications.

- **Grading and tracking student work**—Integrated learning systems and mobile, handheld technologies help teachers quickly assess and track student progress, giving them the rapid feedback they need to make adjustments to their learning paths.
- **Providing faster access to information sources**—Students use the Internet and email to do research and collect data that would take much longer to gather by traditional delivery methods.
- **Saving money on consumable materials**—Software tools such as drill-and-practice and simulations optimize scarce funds by taking the place of materials (e.g., worksheets, handouts, animals for dissection) that are used and replaced each year.

Problem 3: How to prepare students for future learning? As the discussion of 21st Century Skills earlier in this chapter showed, skills that students will need in the future will focus more on "learning to learn" skills, such as thinking creatively and reasoning effectively, than on memorizing facts, definitions, and rules. To learn these skills, students will need the three forms of literacy that are thread through all 21st century learning.

- **Technological literacy**—Technologies such as word processing, spreadsheets, simulations, multimedia, and the Internet have become increasingly essential in analyzing and producing information in school settings and on the job. Students who use these tools in school have a head start on what to do in the workplace.
- **Information literacy**—Analyzing and using information also requires what Johnson and Eisenberg (1996) called the "Big Six" skills (task definition, information seeking strategies, location and access, use of information, synthesis, and evaluation).
- **Visual literacy**—In our technology-immersed society, images are increasingly replacing text as communication media. Students must learn to interpret, understand, and appreciate the meaning of visual messages; communicate more effectively through applying the basic principles and concepts of visual design; produce visual messages using the computer and other technology; and use visual thinking to conceptualize solutions to problems (Christopherson, 1997, p. 173).

When combined with recent research findings on potential for impact, these reasons pose a powerful rationale for why technology must become as commonplace in education as it is in other areas of society. They also help point out specific ways to integrate technology into teaching and learning. A summary of the elements underlying a rationale for using technology in teaching is given in Figure 1.5.

TOMORROW'S EDUCATIONAL TECHNOLOGY: EMERGING TRENDS IN TOOLS AND APPLICATIONS

Visions of the future are suffused with images of technologies that may seem magical and far-fetched now, just as cell phones and other mobile technologies seemed only a few decades ago. And, although the technology images we see when we look into the future of education are murky and ill-defined, we know that they will mirror current technical trends and the goals and priorities we set today for

FIGURE 1.5 Why Use Technology? A Summary Rationale Based on Problem Solving

Problem 1: How to motivate and engage students?

- Gains learner attention
- Supports manual operations during high-level learning
- Illustrates real-world relevance through highly visual presentations
- Engages students through production work
- Connects students with audiences for their writing
- Engages learners through real-world situations and collaborations
- Provides support for working cooperatively

Problem 2: How to support students' learning needs?

- Supports effective skill practice
- Helps students visualize underlying concepts in unfamiliar or abstract topics
- Lets students study systems in unique ways
- Gives access to unique information sources and populations
- Supplies self-paced learning for accelerated students
- Turns disabilities into capabilities
- Saves time on production tasks
- Grades and tracks student work
- Provides faster access to information sources
- Saves money on consumable materials

Problem 3: How to prepare students for future learning?

- The need for technological literacy
- The need for information literacy
- The need for visual literacy

tomorrow's education. As with so many "miraculous" technologies, the question is how we will take advantage of their capabilities to bring about the kind of future education systems our society wants and our economy needs.

Trends in Hardware and Software Development

For emerging developments with great potential for impact on education, we turn to the annual Horizon Report, a product of the New Media Consortium's Horizon Project. This project was established in 2002 to identify and describe emerging technologies that are "likely to have a large impact over the coming five years on a variety of sectors around the globe" and have "potential impact on and use in teaching, learning, and creative inquiry" (Johnson, Smith, Willis, Levine, & Haywood, 2011, p. 2). The report is the result of collaboration between the New Media Consortium (NMC) and the EDUCAUSE Learning Initiative (ELI). Though its focus is on postsecondary education, five of the emerging trends the report identifies also seem likely to impact K–12 education. All of these hardware/software trends are emerging in concert with a trend noted in a previous Horizon Report: computing is increasingly cloud-based, with information and programs stored in servers and accessed online, rather than from individual computers. Other researchers predict increased use of devices with artificial intelligence, such as robots that emulate some teacher functions (Stansberry, 2010). **Artificial intelligence (AI)** refers to computer programs that try to emulate the decision-making capabilities of the human mind. However, these predictions seem further in the future, if they come about at all.

Trend #1: Ubiquitous mobile computing. As the authors point out, the trend toward mobile devices in education is already being seen and is likely to be widespread in higher education beginning in 2012. It also seems likely to have great impact on K–12 education, though concerns about curriculum, privacy, classroom management, and uniform access may take longer to address in schools.

Trend #2: More sources of open content. When combined with open-source materials, open content means that more courses and educational materials that were previously proprietary will now be free and available to everyone online. It is emerging as a response to "the rising costs of education, the desire for access to learning in areas where such access is difficult, and an expression of student choice about when and how to learn" (Johnson, Levine, Smith, & Stone, 2010, p. 6). Already being seeing in higher education—some universities are offering for free courses that were previously tuition-based—this trend also means more free content available to K–12 teachers and students.

Trend #3: Increased ebook presence. Though ebooks have been available for decades, their technical sophistication has recently increased dramatically. They are now seen as having real, near-term potential to "reduce costs, save students from carrying pounds of textbooks, and contribute to the environmental efforts of paper-conscious campuses" (Johnson, Levine, Smith, & Stone, 2010, p. 6).

Trend #4: Augmented reality systems. Coined by a Boeing researcher in 1990, the term **augmented reality** refers to a computer-generated environment in which a real-life scene is overlaid with information that enhances our understanding and uses of it. Examples have been evident in industry and military environments for years, but most people became aware of it in movies such as *Minority Report, Iron Man*, and *Stranger Than Fiction*. Now simple versions of these systems are available to schools on mobile devices for applications such as GPS and maps of the sky.

Trend #5: Gesture-based computing. Devices that we can control through moving a hand or other body part are changing the way people interact with computers. With **gesture-recognition systems,** a camera or sensor reads body movements and communicates them to a computer, which processes the gestures as commands and uses them to control devices or displays. The most commonly seen examples of this technology are the Nintendo Wii and mobile devices

One trend in hardware and software is an increasing e-book presence.
Photo by W. Wiencke.

such as the Apple iPad. Gesture-based technology has the potential to enhance teaching simulations by making them more lifelike and intuitive to use.

Trends in Educational Applications

As the Horizon Report notes, these hardware/software trends are important because they support current and emerging society-wide conditions for education:

- People expect to work, learn, and study whenever and wherever they want to.
- Students' work is increasingly seen as collaborative, rather than individual.
- Digital media literacy is an increasingly key skill in every discipline.

These technology trends and the conditions in which they are emerging augur a dramatically transformed education system:

Trend #1: Flexible learning environments. No longer do students have to leave classrooms for "pull-out" activities in labs. With wireless communications and portable devices, now the lab comes to the students, and learning environments can be located beyond the walls of classrooms and schools. Students can take notes, gather data, or do research from wherever they are and have easy, fast access to resources such as writing labs and digital production labs. Curtis, Williams, Norris, O'Leary, and Soloway (2003) describe how to manage and carry out lessons that maximize the flexibility of handheld devices. Norris and Soloway (2010) report on four district-wide pilot programs using these devices to enable innovative learning environments. Bonk (2010) describes the implications of these environments for "re-imagining" school. New technologies such as the LiveScribe Echo "smart pen" are emerging that require educators to think creatively about how best to use these new environments (Thompson, 2010; see Figure 1.6).

Trend #2: Adaptable assessment options. New technologies are already having an impact on how educators assess students, and more changes seem likely in the future. Teachers are beginning to use handheld devices to make monitoring students' progress more immediate and continuous. As standards and accountability loom ever larger on the horizon, continuous assessment becomes more important, making it easier to guide student progress and to ensure success on tests. Shihadeh-Shald (2010) and Kenwright (2009) report on uses of student response systems (SRS), or "clickers," that support the kinds of continuous assessment students need in order to self-monitor their progress.

Trend #3: Emphasis on communication and collaboration. The ubiquity of computer power has made possible

FIGURE 1.6 LiveScribe Echo Smart Pen

Devices such as the LiveScribe Echo smart pen, which can record and play audio to accompany written text and images, help make possible innovative learning environments.
Source: Reprinted by permission of LiveScribe.

an ever-expanding number of avenues for expressing opinions and sharing information. As educators and students become aware that they can share their ideas with the world through collaborative tools such as blogs and wikis, there is a growing need for learning both the skills and ethics of online communication. Collaborative strategies include **crowdsourcing,** a type of "outsourcing" in which many people are asked to give their input on solving a problem that has proven resistant to efforts of single individuals or organizations. Even the U.S. Department of Education (ED) has recognized the usefulness of this strategy with a grant program that uses crowdsourcing to encourage educators to identify and solve some of K–12 education's most pressing classroom challenges ("New grant program seeks solutions," 2010).

Trend #4: Reliance on learning at a distance. As high-speed connections become more readily available to schools and homes, the number of students learning through virtual systems is steadily increasing. Many states sponsor a virtual high school, and many organizations offer courses for junior high and even elementary students (Watson, Murin, Vashaw, Gemin, & Rapp, 2010). Though currently fraught with controversy, distance learning for K–12 students eventually will have the same degree of impact on reshaping schools as it has had on redefining higher education.

Trend #5: Increased educational options for students with disabilities. New technologies continue to make the most dramatic advances in opportunities for people with disabilities. Kurzweil (http://www.kurzweilai.net) describes immersion systems and intelligent programs that help people with sensory impairments and physical disabilities function effectively in learning situations. Bargerhuff, Cowan, Oliveira, Quek, and Fang (2010) describe **virtual reality (VR)** uses for those with visual impairments. Because all students, including those with disabilities, must meet high standards of achievement, it seems likely that schools will increase their investments in new assistive technologies.

SUMMARY

The following is a summary of the main points covered in this chapter.

1. Introduction: The "Big Picture" on Technology in Education— Four perspectives help define educational technology. See sites for AECT, ITEEA, and ISTE (see Table 1.1), educational technology organizations that have represented one or more of the four views of educational technology described in this chapter.

2. Yesterday's Educational Technology—Four eras comprise the history of educational computing/technology: the pre-microcomputer era (1950–late 1970s); the microcomputer era (late 1970s–1994); the Internet era (1994–2005); and mobile technologies and the era of ubiquitous access (2005–present). What we have learned from the history of technology in education:

- No technology is a panacea for education.
- Teachers usually do not develop technology materials or curriculum.
- "Technically possible" does not equal "desirable, feasible, or inevitable."
- Technologies change faster than teachers can keep up.
- Older technologies can be useful.
- Teachers always will be more important than technology.

3. Today's Educational Technology Resources—These include: hardware, software, and storage media (such as flash drives).

4. Today's Educational Technology Issues—These include: social issues, educational issues, cultural/equity issues, and legal/ethical issues.

5. Today's Educational Technology Skills—These include: NETS for Students, Teachers, and Administrators; 21st Century Skills for Students and Teachers; and the ICT Competency Framework for Teachers. Various portfolio options are available for teachers to document their skills in meeting these standards.

6. A Rationale for Using Educational Technology—Use knowledge of promising practices and approaches based on solving educational problems to develop a personal rationale for using technology in education.

7. Emerging Trends in Tools and Applications—Trends in tools include: ubiquitous mobile computing, more sources of open content, increased ebook presence, augmented reality systems, and gesture-based computing. Emerging trends in educational applications resulting from these tools include: flexible learning environments, adaptable assessment options, emphasis on communication and collaboration, increased reliance on learning at a distance, and increased educational options for students with disabilities.

ISSUES

for Collaborative Discussion and Reflection

The following questions may be used either for in-class, small-group discussions or may initiate discussions in blogs or online discussion boards:

1. The 2011 Horizon Report said, "The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators in sense-making, coaching, and credentialing" (p. 3). What examples could you cite to show the ways in which this is happening?

2. In Clay Shirkey's 2010 book, *The Souls of the Machine*, he predicts a future transformed by online tools: "Who needs an academic association, for instance, if a Facebook page, blog, and Internet mailing list can enable professionals to stay connected without paying dues? Who needs a record label, when musicians can distribute songs and reach out to fans on their own?" (Young, 2010, p. 7). What examples can you give to refute or support Shirkey's predictions?

3. Gene Glass, originator of meta-analysis techniques, said, "experienced education leaders worry that something is lost when teachers are replaced by avatars and real life is replaced by Facebook … only a fool believes everything that can be gained from face-to-face teaching and learning also can be acquired online" (2010, p. 34). Give examples from research and practice to support or refute Glass's analysis.

4. Research on uses of educational technology—Use the ISTE Center for Applied Research in Educational Technology (CARET) website at http://caret.iste.org to learn what research can teach us about effective uses of technology for learning. Use the Search feature to do a keyword search for research related to a specific subject area, such as science or writing. From the list of results, read three of the article reviews or answers. Summarize what you learned about using technology to teach that subject.

5. Technology integration—Visit *Edutopia* at *http://www.edutopia.org*. At the *Edutopia* website, click on the Video Library tab to access the video collection. In the Search by Topic window, use the menu to browse videos by topic, and select Technology Integration. Watch one of the videos. (a) Which of the perspectives that shaped educational technology is evident in the video? (b) Refer to Figure 1.5 in the textbook, and list elements that show why technology is being used in the video.

6. Educational technology historian Paul Saettler (1990) said, "Computer information systems are not just objective recording devices. They also reflect concepts, hopes, beliefs, attitudes" (p. 539). Discuss the concepts, hopes, beliefs, and attitudes our past and current uses of technology in education reflect.

7. Richard Clark's now-famous comment about the impact of computers on learning was that the best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in our nutrition (Clark, 1983, p. 445). Why has this statement had such a dramatic impact on the field of educational technology? How would you respond to it?

8. In their study of students' reasons for online plagiarism, Comas-Forgas and Sureda-Negre (2010) found that some students say it "is easier, simpler and more comfortable than doing the work yourself" (p. 223). Can you suggest arguments that would help persuade students that online plagiarism, while easy and quick, is not in their best interests?

TECHNOLOGY INTEGRATION WORKSHOP

FOR YOUR TEACHING PORTFOLIO

As you move through your teacher preparation program, you will see opportunities for adding products to a teaching portfolio that show what you know about and are able to do with technology.

In this chapter, review the section entitled Demonstrating Technology Skills: Portfolio Options (p. 21), determine the portfolio requirements for your program, and begin creating your portfolio structure. As you complete your own structure, include the product from your group's Hot Topic Debates for Class Discussion.

MyEducationLab™

To check your comprehension of the content covered in this chapter, go to MyEducationLab, select your text, and complete the Study Plan and consult the Book Resources. You will find:

- A pretest with hints and feedback that tests your knowledge of this chapter's content
- Review, practice, and enrichment activities that will enhance your understanding of the chapter content
- A posttest with hints and feedback that allows you to test your knowledge again after having completed the enrichment activities
- Flashcards based on the key terms presented throughout the chapter
- Technology Integration Workshop Activities 2–5

A correlation guide that aligns chapter content with the Educational Technology **MyEducationLab** is available to instructors.