

Pearson New International Edition



Integrating Educational Technology  
into Teaching  
M. D. Roblyer / Aaron H. Doering  
Sixth Edition

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PEARSON

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# GLOSSARY

- accelerometer**—A device that assists with analyzing and monitoring physical fitness levels by counting calories
- Acceptable Use Policy (AUP)**—An agreement created by a school or other educational organization that describes the risks involved in Internet use; outlines appropriate, safe student behavior on the Internet; asks students if they agree to use the Internet under these conditions; and asks what information about themselves, if any, may be posted on the school’s website
- accommodation**—Piagetian view of how children change their views of the world by incorporating new experiences
- ActionScript**—In Adobe® Flash®, an advanced authoring environment for creating content for the web, a mobile, or virtually any digital platform
- Adequate Yearly Progress (AYP)**—(See No Child Left Behind (NCLB) Act of 2001.)
- adventure learning (AL)**—A hybrid (online and in-person) distance education approach that provides students with opportunities to explore real-world issues through authentic learning experiences within collaborative learning environments
- alternative keyboard**—Customized keyboards created for users with special needs (e.g., enlarging the keys to provide more space for the student to press a key; removing keys that are not relevant for a given software; programming multi-step functions like save, print, quit into a single key press)
- app**—Abbreviation for application, software that normally has an extension of .app and refers to any Internet application specifically designed to run on mobile devices such as smartphones
- applications programs**—Computer software written to support tasks that are useful to a computer user (e.g., word processing) in contrast with systems software
- applications software**—(See applications programs.)
- aptitude-treatment interaction (ATI)**—Research finding that formats that are beneficial for one group have a negative impact on a group with the opposite characteristic
- ARPAnet**—A network created in 1969 by the U.S. government-funded Advanced Research Projects Agency (ARPA) to enable communications among important defense sites in the event of a worldwide catastrophe such as a nuclear attack; later became the Internet
- artificial intelligence (AI)**—Computer programs that try to emulate the decision-making capabilities of the human mind
- ASP.NET**—First released in 2002, a scripting language that must be installed on a server to be used in web development; a scripting language that generates HTML source code to create dynamic web pages (See also PHP.)
- assimilation**—Piagetian view of how children learn by fitting new experiences into their existing view of the world
- assistive technology**—Devices that extend the abilities of an individual in ways that provide physical access (i.e., wheelchairs, braces) and sensory access (i.e., Braille, closed captioning)
- asynchronous**—Form of distance communications in which information and messages are left for the receiver to read later; contrasts with synchronous communications, in which information and messages are sent and received immediately (See also synchronous.)
- Audio Video Interleave (AVI) format**—One of several digital formats for video that are able to be used with video editing software
- augmented reality**—Coined by a Boeing researcher in 1990, it refers to a computer-generated environment in which a real-life scene is overlaid with information that enhances our understanding and uses of it
- autocorrect**—A built-in feature of word-processing software that automatically detects and corrects misspelled words and incorrect capitalization
- automaticity**—A level of skill that allows a person to respond immediately (i.e., automatically) with the correct answer to a problem
- auto-tuning**—A unique vocal distortion technique made possible with vocal-editing software
- avatar**—A graphic representation of a real person in cyberspace; a three-dimensional image that a person can choose to represent himself or herself in a virtual reality environment
- avatar spaces**—Online environments in which users can interact through their graphic representations (i.e., avatars)
- Blended Intercultural Collaborations**—In language learning, “international class-to-class partnerships in which projects and tasks are developed by the partner teachers in the collaborating institutions” (O’Dowd, 2011, p. 3); students work with students of other cultures to provide authentic writing and research experiences
- blended learning**—(See hybrid learning.)
- blog**—Short for “web log,” a web page that serves as a publicly accessible location for discussing a topic or issue; began as personal journals and expanded to become public discussion forums in which anyone can give opinions on a topic
- blood pressure devices**—Devices that assist with analyzing and monitoring physical fitness levels by monitoring and reporting blood pressure
- BMP**—Stands for “bitmapped.” Developed originally for use on Disk Operating System (DOS) and Windows-compatible computers, an image format used for drawn images, illustrations, clip art, or animations
- body composition analyzer**—A device that assists with analyzing and monitoring physical fitness levels by determining the percent of body fat
- bookmarks file**—In a browser, a set of Internet locations or URLs organized so that a user can return to them quickly (See also favorites file.)
- browser**—Also known as a web browser, software designed to allow a computer user to go to Internet web sites that are connected to each other via the World Wide Web (WWW)
- bulletin board (BB)**—A computer system set up to allow notices to be posted and viewed by anyone who has access to the network
- calculator-based lab (CBL)**—Calculator with probes or sensors connected to it to allow gathering of numerical data
- cell**—In a spreadsheet, a row-column location that may contain numerical values, words, or character data, and formulas or calculation commands
- charting/graphing tools**—Software tools that automatically draw and print desired charts or graphs from data entered by users
- chatroom**—A location on the Internet set up to allow people to converse in real time by typing in messages or allowing their avatars to meet and “talk” to each other
- classical conditioning**—Pavlovian view of learning as involuntary physical responses to outside stimuli (e.g., dogs salivate automatically at the sight of a dog food can)
- clickers**—(See student response systems or SRS.)
- clip art**—One or more pieces of professionally prepared art work, stored as files and designed to be inserted into a document or web page
- closed circuit television (CCTV)**—A magnification system in which a video camera is mounted on a frame with a television monitor. Users

- place materials on the desktop below the camera, set the desired magnification level, move the materials around as necessary, and information appears on the monitor in a size that can be read comfortably by an individual with visual impairments
- cloud computing**—The practice of storing software on servers that are accessed through the Internet
- Cloze exercises**—Comprehension exercises with certain words removed to require students to fill in the blanks
- cognitive load**—The amount of working memory that is available to a learner to process new information and that is taken up at a given time by a learning task
- Common Gateway Interface (CGI)**—An authoring specification on the Internet for how data will be collected at a website; CGI programs are written in a language such as PERL
- compensation**—Using technology to accommodate difficulties individuals have with performing specific tasks, e.g., providing speech recognition software to those with physical disabilities that limit their use of a pencil or a keyboard
- computer adaptive testing (CAT)**—Computer software that continuously analyzes a student's test responses and presents more or less difficult questions based on the student's performance (See also computer-assisted testing.)
- computer algebra system (CAS)**—Either software or devices with software that help carry out complex numeric calculations involved in higher-level math problems (e.g., Maple)
- computer-assisted design (CAD)**—Software used by architects and others to aid in the design of structures such as houses and cars
- computer-assisted instruction (CAI)**—Software designed to help teach information and/or skills related to a topic; also known as instructional software or courseware, computer-based instruction (CBI), computer-based learning (CBL), computer-assisted learning (CAL), or generic terms such as software learning tools
- computer-assisted language learning (CALL)**—For learners of English and foreign languages, activities in which they use computers in language testing, teaching, and learning in and out of class
- computer-assisted testing (CAT)**—Using a computer system to administer and score assessment measures; also, computer adaptive testing, computer-based testing
- computerized kiln**—Oven for firing ceramic products that uses computers to perform automatically several operations: set required temperature, monitor length of firing time, and begin the process of cooling down and shutting off
- computer-managed instruction (CMI)**—Computer software systems designed to keep track of student performance data, either as part of CAI programs or by themselves
- computer platforms**—Types of computer systems identified by their operating systems, e.g., PCs with Windows operating systems or Macintoshes with Mac-OS operating systems
- computer programs**—(See software.)
- concept-mapping software**—Tools designed to help people think through and explore ideas or topics by developing concept maps (i.e., visual outlines of ideas)
- constructivism**—The belief system that holds that humans construct all knowledge in their minds by participating in certain experiences; knowledge is the result of constructing both mechanisms for learning and one's own unique version of the knowledge, colored by background, experiences, and aptitudes
- constructivist learning**—Teaching/learning model based on cognitive learning theory; holds that learners should generate their own knowledge through experience-based activities rather than being taught it by teachers (See also directed instruction.)
- contingencies of reinforcement**—According to learning theorist B. F. Skinner, experiences (positive reinforcement, negative reinforcement, punishment) that shape desired behavioral responses
- cookie**—A small text file transferred to a web browser through an Internet server for the purpose of tracking the Internet usage habits of the person using the browser
- course management system (CMS)**—An online system of web course design and delivery tools; Desire-to-Learn and BlackBoard are examples
- courseware**—(See computer-assisted instruction or CAI.)
- crowdsourcing**—A type of outsourcing in which many people are asked to give their input online to solve a problem that has proven resistant to efforts of single individuals or organizations
- cyberbullying**—Growing problem of online harassment in social networks
- cybercheating**—In education, academic dishonesty in which someone uses another's work obtained from the Internet as his/her own, also known as online cheating
- cyberporn**—General term for any pornographic Internet site
- database**—A collection of information systematized by computer software to allow storage and easy retrieval through keyword searching; the program designed to accomplish these tasks
- data loggers**—Devices that record data over time with sensors
- data mining**—The practice of collecting data from all the information available and searching it to see relationships among the data elements
- design**—A first step in web development that involves planning what the website will look like. (See also storyboard.)
- desktop publishing**—Term coined in 1984 by the president of the Aldus Corporation to refer to the activity of using software to produce documents with elaborate control of the form and appearance of individual pages
- Digital Divide**—Term coined by Lloyd Morrisett, former president of the Markle Foundation, to mean a discrepancy in access to technology resources among socioeconomic groups
- digital literacy**—Originally, the ability to use computer devices and software to locate and use information; now refers to skills in using the information that technological devices carry, in addition to skills in using the devices themselves
- digital storytelling**—Using digitally-produced images and audio to tell the stories of lives, events, or eras
- directed instruction**—A teaching and learning model based on behavioral and cognitive theories; students receive information from teachers and do teacher-directed activities (See also constructivist learning.)
- disability**—Condition that occurs when an impairment limits an individual from performing an activity in a manner normally expected for human beings (communicating with others, hearing, movement, manipulating objects, etc.) (See also handicap and impairment.)
- discovery learning**—According to learning theorist Jerome Bruner, a more effective way of children learning concepts by discovering them during their interaction with the environment
- disequilibrium**—Piagetian view of condition children experience when they confront new and unfamiliar features of their environment that do not fit with their current views of the world
- distance education**—A form of education in which some means, electronic or otherwise, is used to connect people with instructors and/or resources that can help them acquire knowledge and skills. According to Holden & Westfall (2010), "structured learning that takes place without the physical presence of the instructor" (p. 3). Sometimes used as synonymous with "distance learning"

- domain designator**—Also referred to as a domain name, a required part of a Uniform Resource Locator (URL) on the Internet that indicates what kind of group owns the server; examples include “.edu,” “.com,” and “.org”
- domain name**—(See domain designator.)
- download**—To bring information (e.g., text files, images) to a computer from the Internet or other network or from a computer to a disc
- drill and practice**—An instructional software function that presents items for students to work on (usually one at a time) and gives feedback on correctness; designed to help users remember isolated facts or concepts and recall them quickly
- e-books (ebooks)**—Texts in digital form that may be read on a computer or e-book readers; becoming a popular alternative to printed texts
- educational technology**—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
- electronic field trip**—(See virtual field trip.)
- electronic gradebook**—Software designed to maintain and calculate student grades
- electronic mentor**—Subject matter expert who volunteers to work closely with students online
- electronic outliner**—(See outlining tools.)
- electronic portfolio**—A collection of a person’s work products over time, arranged so that he or she and others can see how skills have developed and progressed, and presented in an electronic format such as a website or multimedia product (See also portfolio.)
- electronic publishing**—Activity when students submit their written or artistic products to a website
- electronic slide shows**—Sequences of frames shown in a linear way with presentation software (e.g., *PowerPoint*)
- electronic storybooks**—Stories that can be read from a computer screen, on mobile devices, or as print books with interactive buttons; also known as interactive storybooks
- enactive learning**—Proposed by learning theorist Albert Bandura as learning that occurs through actions, rather than by observation
- English as a Second Language (ESL)**—Designates a type of learning of English that occurs after a student achieves some level of proficiency in another, native language; more commonly-used term is now English Language Learning or ELL
- English Language Learners (ELL)**—Individuals who are learning English as their majority language for everyday uses, employment, and educational purposes. ELL also stands for English Language Learning
- e-portfolio**—Websites created by students to showcase their work and organize, revise, and store digital assets that they have created inside and outside the classroom
- EPS (Encapsulated PostScript)**—An image format that allows transfer of artwork between any software packages that use PostScript printing files
- essential processing**—In cognitive load theory, cognitive processes that are required for making sense of material a person is trying to learn can overwhelm learner’s cognitive capacity unless strategies are in place to handle it by learning theorist Robert Gagné as being involved in teaching and learning
- exergaming**—“Video games that provide physical activity or exercise through interactive play” (Mears and Hansen, 2009, p. 29)
- EXtensible Mark-up Language**—(See XML.)
- extraneous processing**—In cognitive load theory, mental activity uses cognitive capacity but does not help the learner learn
- favorites file**—In a browser, a set of Internet locations or URLs organized so that a user can return to them quickly (See also bookmarks file.)
- field**—The smallest unit of information in a database
- files**—The products created by a database program; any collection of data stored in a computer or on a computer medium
- File Transfer Protocol (FTP)**—On the Internet, a way of transferring files from one computer to another using common settings and transmission procedures; also, to transfer files
- filtering software**—Program stored on individual computers or on the school or district network in order to prevent access to Internet sites with inappropriate materials
- firewall**—Software that protects a school’s or company’s entire computer system from attempts by others to gain unauthorized access to it and also prevents access by users to certain sites
- firewall software**—Programs set up to prevent someone from going to certain locations on the Internet; prevention may be by keyword or by site name
- Flash**—A type of hypermedia authoring software from Adobe that has become commonly used to create interactive web-based animations
- FM amplification system**—Resource for students with hearing impairments in which the teacher wears a wireless microphone and students with auditory processing learning disabilities wear receivers that amplify the teacher’s voice and serve to focus attention
- font**—Typeface used in word processing or desktop publishing
- foreign language (FL)**—A target language, or language of study, when the language being studied is spoken mainly in other countries
- foreign language dictionaries**—Online sites that function like other dictionaries in that they give definitions for words and phrases in common usage, but provide the additional capability of looking up the word or phrase in one language (e.g., French or German) and get the definition and/or synonyms for it in another language (e.g., English)
- forms makers**—Software tools that create documents and web pages with “fillable” forms
- formula**—In a spreadsheet, a command inserted in a cell and used to do calculations on data
- frame**—Sections programmed to display on a web page; the contents of each frame are actually different web pages displayed on one screen
- full immersion systems**—Type of virtual reality (VR) system in which a user places a headset (e.g., goggles or a helmet) over the eyes to provide a channel through which the wearer “sees” (i.e., is immersed in) a computer-generated environment
- generative processing**—In cognitive load theory, the use of working memory that results in productive, engaged learning
- geocaching**—An online activity in which students look at a database of caches listed at a geocaching website (e.g., <http://www.geocaching.com>), decide on a cache to hunt for, use GPSs to help them locate it, and share their experiences with others involved in the hunt
- Geographic Information System (GIS)**—A computer system that stores and manipulates a database of information about geographic locations; users see data pertaining to a geographic location overlaid on a map of the area
- geospatial technologies**—Systems that allow individuals to view and examine the world through multiple layering of geographic data within a spatial environment; use of technology for visualization, analysis, and measurement of features and phenomena
- gesture-recognition system**—System in which 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
- GIF (Graphics Interchange Format)**—An image format used for drawn images, illustrations, clip art, or animations



- Global Positioning System (GPS)**—A worldwide radio-navigation system made possible by a bank of orbiting satellites and their ground stations to pinpoint exact geographic locations on earth; a device that cross-references a GPS signal with mapping software and shows the location to a user
- Google Docs**—Tools offered through a special Google site that provide users access to online programs for word processing, spreadsheets, and presentations; the site offers storage of documents on a Google server and allows for sharing of documents among multiple users
- graphic document makers**—Software tools that simplify the activity of making highly graphic materials such as awards certificates and greeting cards by offering sets of clip art and pre-designed templates to which people add their own content
- graphing calculator**—Advanced calculators that can graph equations, as well as perform calculation functions involved in higher-level math and science problems; allows users to enter equations and shows graphs that result from those equations
- group product development**—Learning activities in which students write papers, develop concept maps, and develop presentations collaboratively online using tools such as Google Docs
- hacker**—Computer user who engages in unauthorized use of a computer system
- hacking**—Use of online systems to access personal data in order to accomplish identity theft and do other malicious acts
- handheld technologies**—Small, multi-purpose devices such as cell-phones, e-books, and “smart” pens that make it easy to view, communicate, and share information, regardless of location (See also mobile device.)
- handicap**—A condition that arises when an individual is unable to fulfill a role due to an impairment or disability (See also impairment and disability.)
- hands-on/minds-on science**—A common term in science education reform, synonymous with immersing students in authentic learning experiences
- haptic interface**—One of the devices (e.g., a data glove) that allow users to experience a full immersion virtual reality system by providing tactile or touch input
- hardware**—The devices or equipment in a computer system (in contrast with software or computer programs)
- hash tag**—A term used on the Twitter system for a prefix to a message (Tweet) consisting of a pound sign (#) and a topic name (e.g., #ripstevjobs). Users begin a Tweet with a hash tag to allow others to identify posts and create their own messages on that topic.
- head-mounted display (HMD)**—In a full immersion virtual reality (VR) system, a headset that provides the sensory channel through which the wearer “sees” a computer-generated environment
- heart rate monitor**—Device consisting of a transmitter, which senses the heartbeat from the heart’s electrical impulses, and a wristwatch receiver, which receives and records each beat through radio transmission from the transmitter
- hits**—Pages or items listed as results of an Internet or database search
- HTML**—(See Hypertext Markup Language.)
- HTML 5**—A revision of the HTML standard that provides many of the features of a Flash environment without using Flash (See also Flash.)
- hybrid learning**—In distance education, opportunities that allow students to blend online and face-to-face learning; also referred to as blended learning
- hypermedia**—Software that allows information stored in various media or various parts of media to be connected (often via the Internet)
- hypertext**—On the Internet, texts that contain links to other texts
- Hypertext Markup Language (HTML)**—The primary authoring language used to develop web pages
- i-dosing (idosing)**—Going to sites that allegedly induce a state of ecstasy from listening to music
- IEP generator**—Software that assists teachers in preparing individual educational plans (IEPs) required by law for students with special needs; automates the process by providing on-screen prompts that remind teachers of the required components in the plan
- image editing programs**—Software tools used to enhance and format photos that are then imported into desktop publishing systems or web page products
- image formats**—Ways of storing digitized images for use in web pages and multimedia products, e.g., GIF, JPEG
- impairment**—An abnormality or loss of function in a physical, anatomical, or psychological structure; may be congenital (present at birth) or acquired through accident or disease (See also handicap and disability.)
- inclusion**—Activity in which students with disabilities are included in the general education classroom; often used interchangeably with “mainstreaming,” though the terms originally had different meanings (See also mainstreaming.)
- individualized educational program (IEP)**—The educational program required by law to be designed for each student with a disability
- inert knowledge**—A term introduced by Whitehead in 1929 to mean skills that students learn in isolation but do not know how to transfer later to problems that require them
- information and communication technology (ICT)**—New term for information technology or educational technology; refers to all technologies used in education and training, as well as strategies for using them; originally in more common use outside the U.S., but becoming more popular worldwide due to UNESCO’s ICT standards for education
- information literacy**—According to the American Library Association (ALA), “a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (2000, p. 2)
- information visualization**—Also known as information design, “uses pictures, symbols, colors, and words to communicate ideas, illustrate information, or express relationships visually” (Emerson, 2008, p. 4)
- inquiry-based learning**—(See constructivist learning.)
- instant messaging (IM)**—A communications service that allows users to create a private chat room which only members of a mutually agreed-upon list may enter; the system alerts a user when someone from the IM list is online; IM also designates the act of instant messaging, as in “to IM”
- instructional game**—Type of software function designed to increase motivation by adding game rules to a learning activity
- instructional software**—Applications software that is designed specifically to deliver or assist with student instruction on a topic (See also courseware.)
- instructional technology**—The subset of educational technology that deals directly with teaching and learning applications (as opposed to educational administrative applications)
- integrated learning system (ILS)**—Networked or online system that provides both computer-based instruction and summary reports of student progress
- integrated packages**—Software products (e.g., Microsoft Works and AppleWorks) that have several applications in a single package (e.g., word processing, spreadsheet, presentation functions, database programs)
- integrating educational technology**—The process of determining which digital tools and which methods for implementing them are the most appropriate responses to given educational needs and problems

- intelligent tutoring systems**—Sophisticated kinds of branching tutorial software that adapt the sequence of instruction to the needs of each learner
- interactive or dynamic geometry software**—Programs that allow users to create and manipulate geometric constructions and provide environments in which to make discoveries and conjectures related to geometry concepts and objects
- interactive storybooks**—(See electronic storybooks.)
- interactive whiteboard**—A device that includes a display screen connected to a computer and digital projector; allows information projected on the screen to be manipulated with special pens or one's hands and also allows drawings or notes from a given session to be saved and brought back later. Sometimes referred to as an electronic whiteboard.
- interactive whiteboard activity software**—Programs that allow teachers to author and display lessons for use with interactive whiteboard systems
- Internet**—A worldwide collection of computer networks that can exchange information by using a common software standard; sometimes referred to (erroneously) as synonymous with the World Wide Web (WWW), which is actually a subset of the Internet
- intranet**—An internal network or a subset of the Internet, usually available only to the members of the organization that set it up
- Java**—Originally called OAK, a high-level programming language developed by Sun Microsystems. An object-oriented language similar to C++, it has become popular for its ability to do interactive graphic and animation activities on web pages
- Java applets**—Pre-developed applications created with the Java programming language; make possible web page features such as animations and special effects, graphics and buttons, interactive displays, web data collection forms, and chatrooms
- Javascript**—An object-oriented scripting language that, like Java, is used to create dynamic websites
- joystick**—Input device, used primarily with games, that moves on-screen figures or a cursor with a handle that moves in all directions
- JPEG (also JPG)**—Stands for “Joint Photographic Experts Group,” an image format used for photographs
- language translators (machine translation)**—Online sites that allow users to input sentences and paragraphs of text in one language and get a translation into another language
- laptop computer**—Small, stand-alone, portable personal computer system
- learning communities**—Groups of people who “meet,” usually via email, web pages, or other electronic means, to support each other's learning; in distance education, strategic, ongoing efforts by the instructor to encourage student-to-student interaction, as well as student-to-instructor interaction
- learning hierarchies**—According to learning theorist Robert Gagné, a sequenced set of building block skills a student must learn in order to learn a higher-order skill
- Likert scale**—An assessment instrument consisting of a series of statements with which students indicate their degree of agreement or disagreement; created by psychologist Rensis Likert
- link**—Also known as a hot link or hot spot. On the Internet, a piece of text or an image that has been programmed into a web page to send the browser to another Internet location; in a multimedia product, a piece of text or an image that has been programmed to send the user to another location in the product
- listserv (list)**—On the Internet, a program that stores and maintains mailing lists and allows a message to be sent simultaneously to everyone on the list
- logic bomb**—A type of computer virus that is set to “go off” (i.e., carry out its program) at a certain time
- Logo**—A high-level programming language originally designed as an artificial intelligence (AI) language but later popularized by Seymour Papert as an environment to allow children to learn problem-solving behaviors and skills
- long-term memory (LTM)**—According to information-processing learning theorists, one of the three kinds of memory or “stores” the brain uses to process information, much like a computer; LTM can hold information indefinitely after it is linked to prior knowledge already in LTM
- machine translation**—(See language translators.)
- mainstreaming**—An activity in which students with disabilities participate in one or more selected classes in general education; often used interchangeably with “inclusion,” though the terms originally had different meanings (See also inclusion.)
- malware**—Short for malicious software, any software specifically designed to damage, destroy, disrupt operations, or spy on the operation of computers
- mastery learning**—According to learning theorists Benjamin Bloom and B. F. Skinner, an instructional approach in which students learn a sequence of objectives that define mastery of the subject; students pass tests on each objective to demonstrate they have mastered a skill before proceeding to the next one
- meta-analysis**—A statistical method designed by Gene V 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
- microcomputer**—Also called a personal computer, a stand-alone, desktop, or laptop computer that uses a microprocessor and is designed for use by an individual
- microcomputer-based lab (MBL)**—A type of instructional software tool consisting of hardware devices (probes) and software (probeware) to allow scientific data to be gathered and processed by a computer
- mobile device**—General category of portable computer devices such as smart phones and tablets (e.g., iPads) (See also handhelds.)
- morphing**—Short for metamorphosing; refers to an animation technique in which one image gradually turns into another; also known as tweening
- Mosaic**—One of the first browser programs designed to allow Internet resources to be displayed graphically rather than just in text
- Moving Picture Experts Group (MPEG) format**—A file format for storing and sending video sequences on a network
- MUD**—Multiuser dungeon (or dimension or domain); a location on the Internet where several users at a time can interact with each other's avatars (graphic representations of each other); also known as a MUD Object Oriented or MOO
- multimedia**—Literally “multiple media” or “a combination of media,” a software product or system that incorporates combinations of graphics and photographs, sound, motion video, animation, and/or text items for the purpose of communicating information in multiple ways
- multiple intelligences theory**—According to learning theorist Howard Gardner, nine different and relatively independent types of intelligence that may be fostered by differentiated instruction and assessment
- Musical Educators National Conference (MENC)**—Professional organization for music educators
- Musical Instrument Digital Interface (MIDI)**—A standard adopted by the electronic music industry for controlling devices that play music
- music editor**—Software that provides on-screen blank musical bars on which the user enters the musical key, time, and individual notes that constitute a piece of sheet music

- music literacy**—The ability to read standard music notation
- music sequencer**—Can be either software that supports the on-screen creation of music scores with several parts or tracks, or a hardware component of a music synthesizer workstation (See also sequencer.)
- music synthesizer**—Music-making equipment controlled by a Musical Instrument Digital Interface (MIDI) device
- National Education Technology Standards (NETS)**—Benchmark technology skills created by the International Society for Technology in Education (ISTE) for teachers (NETS-T), students (NETS-S), and educational administrators (NETS-A)
- netbook**—A handheld computer that is like a notebook computer but with fewer features
- netiquette**—A contraction of Internet and etiquette, refers to guidelines for posting messages to online services (e.g., email or discussion boards) to demonstrate courtesy and regard for other users
- new literacies**—The new skills, strategies, and insights necessary to utilize the rapidly changing and emerging technologies in the world
- No Child Left Behind (NCLB) Act of 2001**—Federal law that put in place accountability measures of all U.S. students, teachers, and schools; requires schools to demonstrate adequate yearly progress (AYP) toward target goals, as demonstrated by test scores, attendance, and other quality indicators
- notation software**—Software that facilitates music making in the visual domain by allowing flexibility in music score and page setup, part extraction, text formatting, and other print-related issues
- nutritional analysis program**—Software that analyzes calorie intake and monitors portions of required food groups
- objectivism**—A belief system that views knowledge as objective truths that have been established by scientific observation and testing and have a real and separate existence outside human perception; instructional strategies based on objectivist learning theories (i.e., behavioral, cognitive-behavioral, and information processing theories) hold that these objective truths must be transmitted through teacher-directed instructional methods and that learners must demonstrate their knowledge of them
- objectivists**—People who believe that knowledge has a separate existence outside human perception and that it must be transmitted through directed instructional methods, based on behavioral, cognitive-behavioral, and information processing theories
- one-to-one computing**—The practice of allocating a school computer for each student
- open source software**—Computer software available online in which the source code is made available in the public domain and permits users to use, change, and improve the software, and to redistribute it in modified or unmodified form
- operant conditioning**—According to learning theorist B. F. Skinner, a way of shaping human behavior in which the consequences of people's past actions can act as stimuli to shape future behaviors
- optical character recognition (OCR)**—Software that allows text to be scanned and placed in a word processing file
- outlining tools**—Software designed to prompt writers as they develop outlines to structure documents they plan to write
- pedometer**—Device that assists with analyzing and monitoring physical fitness levels by monitoring the number of steps one takes
- phishing**—E-mails that falsely claim to be a legitimate business or user in order to glean private information to be used for identity theft
- PHP**—Like ASP.NET, an application that must be installed on a server to be used in web development; originally stood for personal home page and is a scripting language that generates HTML source code to create dynamic web pages (See also ASP.NET.)
- PICT (picture)**—An image format developed originally for use on Macintosh computers
- plug-in**—A program that adds a specific feature or service to a computer system; many types of audio and video messages are played through plug-ins
- podcast**—A term that combines “iPod” and “broadcast” and coined by British journalist Ben Hammersley in 2005; originally meant digitized audio files saved in a format that can be shared over the Internet for playback on the computer or personal media devices; now can also mean posting video on a site (See also vodcast.)
- portable document format (PDF)**—Format that allows documents to be seen and sent with all the formatting and design elements (e.g., margins, graphics) of the original document without requiring the desktop publishing or word processing software used to create it
- portfolio**—A collection of work products that demonstrate achievement of skills over time; for students, collection arranged so that they and others can see how their skills have developed and progressed (See also electronic portfolio.)
- presentation software**—Type of software that allows a display of information organized as a set of slides (See also electronic slide show.)
- probeware**—(See microcomputer-based laboratory or MBL.)
- problem-based learning (PBL)**—According to Sage (2000), learning organized around the investigation and resolution of an authentic, ill-structured problem
- problem solving**—A complex intellectual function where the learner uses high-order cognitive processes to solve problems and issues that require using a combination of rules
- problem-solving software**—Instructional software function that either teaches specific steps for solving certain problems (e.g., math word problems) or helps the student learn general problem-solving behaviors for a class of problems
- programmed instruction**—Techniques for training and instruction based on learning theorist B. F. Skinner's reinforcement principles
- puzzle generator**—Software tool that automatically formats and creates crossword puzzles, word search puzzles, and similar game-like activities, based on content entered by a user
- Quick Response (QR) code**—A two-dimensional, square-shaped code that may be scanned using a QR code-scanning app on a smartphone. When scanned, the code sends the user to a web site with information, materials, or data.
- QuickTime® movie format (.mov)**—Video sequences that may be viewed on a computer screen by a program designed by Apple Computer Company (i.e., QuickTime)
- QuickTime VR Authoring Studio®**—Software that creates a type of virtual reality (VR) environment by using a series of photographs taken at 360 degrees around a pivotal point and “stitching” them together into a seamless panorama view
- QWERTY keyboard**—Traditional typewriter-like keyboard, so named because of the first six letters in the first line of a typewriter keyboard
- radio frequency identification (RFID)**—An electronic monitoring system that tracks the location of a person or object with an embedded computer chip and can update information on the chip; RFID devices are being field-tested to track student attendance, increase school security, and monitor the location of library resources
- record**—In a database file, several related fields (e.g., all the information on one person)
- relative advantage**—Term coined by Everett Rogers to refer to the perception by potential adopters of how much better an innovative method or resource is than the old one; one of five factors that largely determines whether or not an innovation is adopted

- remediation**—In special education, helping an individual with performance deficits learn or improve through education, training, and therapy
- rubric**—An assessment instrument designed to measure complex behaviors such as writing; for each of several elements in the performance, it gives a set of descriptions of various levels of quality
- sans serif typeface**—Typeface in which letters have no small curves (serifs or “hands and feet”) at the ends of the lines that make them up; usually used for short titles rather than the main text of a document
- scaffolding**—Term associated with learning theorist Vygotsky’s belief that teachers can provide good instruction by finding out where each child is in his or her development and building on the child’s experiences
- scientific inquiry**—The processes of approaching problems scientifically; “the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work...activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” (NSTA National Science Education Standards, p. 23)
- screenagers**—Young people who are...living visually and virtually from handheld screens, smart phones, and computers...(and who) increasingly need multiple forms of literacy, especially visual literacy” (Rushkoff, 2006, p. 48)
- screen reader**—Utility software that operates in the background of the computer operating system, reading aloud any text that appears on the screen (e.g., menus, text, web pages)
- search engine**—A program designed to search documents, either on one’s computer or on the Internet, for keywords, and list the locations of documents where the keywords were found; often used to refer only to programs for Internet searches such as Google
- self-efficacy**—According to learning theorist Albert Bandura, students’ belief in their abilities to accomplish the actions necessary to learn
- semantic differential**—Type of assessment instrument in which students respond to a topic or question by checking a line between each of several sets of bipolar adjectives to indicate their level of feeling about the topic
- sensory disabilities**—Impairments associated with the loss of hearing or vision
- sensory registers**—According to information-processing learning theorists, the parts of the brain that receive information a person senses through receptors (i.e., eyes, ears, nose, mouth, and/or hands) and, after a second or so, is either lost or transferred to short-term memory (STM) or working memory
- sequencer**—A device that facilitates music making in the aural domain by allowing users to record, edit, and play back digital audio and MIDI data (See also music sequencer.)
- serif typeface**—Typeface in which letters have small curves (serifs or “hands and feet”) at the ends of the lines that make them up; usually used for the main text of a document
- sexting**—The practice of sending explicit photos or text messages using cell phones or the Internet
- short-term memory (STM)**—According to information-processing learning theorists, one of the three kinds of memory or “stores” the brain uses to process information, much like a computer; STM can hold information for about 5–20 seconds, after which it is either transferred to long-term memory (LTM) or lost
- simulation**—Type of software that allows users to work with a computerized model of a real or imagined system in order to learn how the system works
- site map**—An at-a-glance guide to the contents of a website
- situated cognition**—According to constructivist learning theorists, instruction anchored in experiences that learners considered authentic because they emulate the behavior of adults
- SMART Table Interactive Learning Center**—An electronic device produced by the Prometheus company that consists of a table with a touch-screen surface and that allows several students to give input to it at the same time
- social action project**—Web-based project in which students are responsible for learning about and addressing important global social, economic, political, or environmental conditions
- social activism theory**—Characteristic agenda of renowned educator John Dewey that shaped his views about teaching and learning; resulted in the belief that social consciousness was the ultimate aim of all education, and learning was useful only in the context of social experience
- social networking site (SNS)**—Sites that focus on building communities; individually designed web pages that allow users to upload their content, meet and connect with friends from around the world, and share media and interests in an online, easy-to-use website environment
- social studies**—According to the National Council for the Social Studies (NCSS, 2010), the integrated study of the social sciences and humanities to promote civic competence
- software**—Programs written in a computer language (in contrast with hardware or equipment) to perform various functions
- software piracy**—Illegally copying and using a copyrighted software package without buying it
- software suite**—A set of programs that perform different functions but are placed in the same package and designed to work well together (e.g., Microsoft Office) (See also integrated packages.)
- spam**—Any unsolicited e-mail message or website posting, usually sent for the purpose of advertising products or services or soliciting funds
- spirometer**—A device that assists with analyzing and monitoring physical fitness levels by measuring lung volume
- spreadsheet**—Software designed to store data (usually, but not always, numeric) by row–column positions known as cells; can also do calculations on the data
- spyware**—Software placed on a computer without the user’s knowledge for the purpose of gathering information about them (usually to sell to marketing firms)
- statistical software packages**—Software tools that help with qualitative data collection and analysis of student performance on tests by performing the calculations involved in any of these kinds of procedures
- storage media**—Materials such as flash drives, CDs, and DVDs that are used to store programs and data outside the computer’s hardware.
- storyboard**—A frame that serves as part of a planning blueprint from which a multimedia product or web page can be designed
- streaming (or streamed) video/audio**—A way of transmitting video or audio on the Internet so that it can be seen or heard as the file downloads
- student information systems (SIS)**—Networked software systems that help educators keep track of student, class, and school data (e.g., attendance, test scores) in order to maintain records and support decision making
- student response systems (SRS)**—(a.k.a., personal response systems, classroom response systems, or clickers) a combination of handheld hardware and software that permits each student in the classroom to answer a question simultaneously and lets the teacher see and display a summary of results immediately
- switches**—In a network, equipment to compress data in order for information to be transmitted at higher speeds [e.g., Asynchronous Transfer Mode (ATM) switches]; in special education, devices that allow a person with a disability an alternative to the typical keyboard and thus allow easier input to the computer

- synchronous**—Form of distance communications in which messages are sent and received immediately; contrasts with asynchronous communications, in which information and messages are left for the receiver to read later (See also asynchronous.)
- systems approaches to instructional design**—Methods originated by educational psychologists such as Robert Gagné and Leslie Briggs, who applied principles from military and industrial training to developing curriculum and instruction for schools; methods used to create a carefully designed system of instruction or instructional design
- talking word processor**—A software package that reads typed words aloud
- Technological Pedagogical Content Knowledge (TPCK, TPACK, or Tech-PACK)**—A framework that identifies a combination of essential skills/knowledge in three areas (content, pedagogy, and technology) that are required if teachers are to integrate technology to greatest effect in their teaching; termed Tech-PACK in this text.
- technology education**—A view of technology in education that originated with industry trainers and vocational educators in the 1980s and is currently represented by the International Technology Education Association (ITEA); holds that (1) school learning should prepare students for the world of work in which they will use technology, and (2) vocational training can help teach all content areas such as math, science, and language
- Tech-PACK**—(See Technological Pedagogical Content Knowledge.)
- telecourses**—A type of distance education where instruction is delivered via video, usually as a broadcast from one site to many sites
- test generator**—Software designed to help teachers prepare and/or administer tests
- test item bank**—Pre-made pools of questions that can be used by test generator software to create various versions of the same test
- text messaging**—An instant form of communications carried out on cell phones and can allow sending images and short videos, as well as text
- TIF (Tagged Image File)**—An image format designed to allow exchange of image files among various software applications and computers
- track changes**—An editing command in word-processing software that can be turned on from one of the program's drop-down menus to show changes as they are made to an original document; changes can either be accepted or rejected
- Trojan horse**—A type of computer virus offered to users as a helpful program but which is actually destructive; named after the giant wooden horse, ostensibly given as a gift from the Greeks to the Trojans (during the Trojan War), and in which Greek soldiers hid to enter the Trojan fortress under cover
- tutorial**—Type of instructional software that offers a complete sequence of instruction on a given topic, including explanation, examples, embedded practice and feedback, and usually, also assessment
- tweneing**—(See morphing.)
- universal app**—App that that work on all platforms (e.g., on a Droid, iPad, iPod, and iPhone) (See also app.)
- universal design**—Adjustments made to physical environments as a result of understanding the special needs of individuals with disabilities, e.g., curb cuts in sidewalks to allow wheelchair access
- URL (Uniform Resource Locator)**—A series of letters and/or symbols that acts as an address for a site on the Internet
- vicarious learning**—Proposed by learning theorist Albert Bandura as learning that occurs through observation, rather than by actions
- videoconferencing**—An online “meeting” between two or more participants at different sites using: a computer or network with appropriate software; video cameras, microphone, and speakers; and telephone lines or other cabling to transmit audio and video signals
- video editing software**—Programs that allow a user to make additions and changes to a selection of digital video (e.g., iMovie)
- video sharing**—(See vodcast.)
- virtual field trip**—Online activities in which students explore unique locations around the world and/or communicate with learners at those sites; also known as electronic field trip
- virtual manipulative**—Software replicas of real objects often used in learning mathematics; are accessed via the Internet and can be manipulated through a keyboard or other input device
- virtual reality (VR)**—A computer-generated environment designed to provide a lifelike simulation of actual settings; often uses a data glove and/or headgear that covers the eyes in order to immerse the user in the simulated environment; representation of real or imaginary worlds in which the user interacts through multiple senses
- virtual reality modeling language (VRML)**—A programming language that allows the creation and display of three-dimensional objects on a computer screen and allows users to have the illusion of moving around the objects
- virtual schooling**—“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)
- virus**—A program written with the purpose of doing harm or mischief to programs, data, and/or hardware components of a computer system (See logic bomb, Trojan Horse, worm.)
- virus protection software**—Software put into place to protect computers from hackers and virus attacks (See hacker, virus.)
- vlog**—A combination of the terms video and blogging, a video version of the blog in which posts are video clips instead of text entries
- vocal processing software**—Programs that are to voice audio what word processing software is to text; allows users to make changes to the pitch and create interesting vocal distortions with recorded voice tracks
- vodcast**—A term that combines “iPod,” “video,” and “broadcast,” refers to digitized video files saved in a format that can be shared over the Internet on sites such as YouTube for playback on the computer or personal media devices site (See also podcast.)
- Voice EXtensible Markup Language (VXML)**—Programming language that helps create environments where a user interacts with the Internet through voice-recognition technology
- VRML (Virtual Reality Modeling Language)**—An authoring specification for displaying three-dimensional objects on the Internet
- web accessibility**—The level to which a website is designed following a set of criteria that make it usable by people with various disabilities
- web-based learning (or lessons)**—General terms for learning or learning activities that take place via the Internet
- web-based programs**—Completely online (on the Internet) courses and curriculum
- web browser**—(See browser.)
- webcam**—A video camera that is connected to a computer in order to gather local video for viewing at other locations
- webcast**—A live video broadcast of an event sent over the Internet
- web design software**—(See web page editors.)
- web page editors**—Authoring programs that allow creation of web pages in the same way word processing is used to create documents
- webquest**—A curriculum project in which students explore websites to find and analyze information on a topic
- Web 2.0 authoring tools**—Authoring tools that are freely available to anyone with an Internet connection and provide users with the powerful capabilities of generating and sharing online content, creating online portfolios, social networking, and tagging or rating other user-generated content

## GLOSSARY

**wiki**—A collection of web pages located in an online community that encourage collaboration and communication of ideas by having users contribute or modify content; contain the ongoing work of many authors

**wireframing**—A stage of creating web pages or websites in which one draws on paper how the web site will appear, including tables, navigation, photos, and other details

**word atlas**—Electronic dictionaries and thesauruses that give pronunciations, definitions, and example uses for each word entry, and offer search and multimedia features similar to those of encyclopedias and atlases

**worksheet**—Another name besides “spreadsheet” for the product of a spreadsheet program

**worksheet generator**—Software tool that helps teachers produce exercises for practice (rather than for assessment) by prompting them to enter questions of various kinds

**World Wide Web (WWW)**—On the Internet, a system that connects sites through hypertext links; now often used synonymously with “Internet”

**worm**—A type of virus that makes copies of itself in order to use up a computer’s resources and slow down or shut down the system

**XML**—Acronym for Extensible Mark-up Language, a language that describes the geometry and behavior of a virtual world or scene

**zombie**—A computer implanted with a program that puts it under the control of a someone without the knowledge of the computer user; usually used in combination with other, similar-infected computers to attack an organization’s computer system and slow it down or shut it down

**zone of proximal development (ZPD)**—Term coined by learning theorist Vygotsky to refer to the difference between two levels of cognitive functioning: adult or expert and child or novice

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# EDUCATIONAL TECHNOLOGY IN CONTEXT

## THE BIG PICTURE



# 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)

### o u t c o m e s

**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.
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.



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### 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



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## 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



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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 Perspectives on Educational Technology and Organizations That Represent Them**

<b>Association for Education Communications and Technology (AECT)</b> <a href="http://www.aect.org">http://www.aect.org</a>	<b>International Technology and Engineering Educators Association (ITEEA)</b> <a href="http://www.iteaconnect.org">http://www.iteaconnect.org</a>	<b>International Society for Technology in Education (ISTE)</b> <a href="http://www.iste.org">http://www.iste.org</a>
<b>Perspectives on Educational Technology</b>		
Initially focused on technology as audio-visual (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
<b>Former Organization Names</b>		
None	Until 1980s: American Industrial Arts Association, then the International Technology Education Association	Until 1988: the International Council for Computers in Education (ICCE)
<b>Current Stated Definitions for Educational Technology</b>		
<i>Educational technology</i> is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources.	<i>Technology education</i> is problem-based learning utilizing math, science and technology principles.	<i>Educational technology</i> 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.

**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 Text 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 text 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 text 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 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,

## FIGURE 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 (ILS) 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



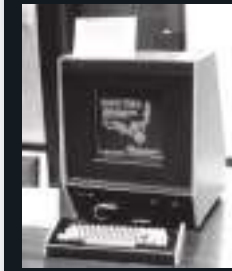
Photo by W. Wiencke.

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

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

Courtesy of Wikipedia

## 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 connect-edness 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,

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

## An Overview of Digital Technology Tools

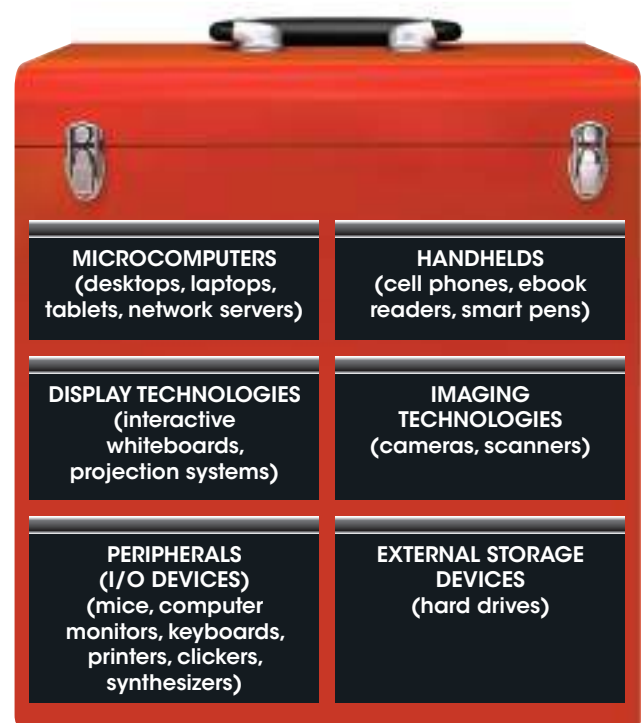
Technology integration strategies require a combination of **hardware**, or equipment, and **software**, or programs, written to perform various functions. Even today's **mobile devices**, or portable, handheld computer equipment, such as cell phones or iPads, have this hardware/software combination. 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 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

**FIGURE 2** The Teacher's Hardware Toolbox



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.

As Table 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 text 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 2** Types of Technology Facilities and How They Are Used

Types of Facilities	Uses	Benefits	Limitations/Problems
<b>Laboratories (usually 20–30 networked computers)</b>			
<b>All labs</b>		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.
<b>Special-purpose labs</b>	<ul style="list-style-type: none"> <li>• Programming or technical courses</li> <li>• Technology education/vocational courses (e.g., with CAD, robotics, desktop publishing stations)</li> <li>• MIDI music labs</li> <li>• Labs dedicated to content area(s) (e.g., mathematics/science, foreign languages)</li> <li>• For use by Chapter or Title III students</li> <li>• Multimedia production work</li> <li>• Teacher work labs</li> </ul>	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.
<b>General-use computer labs</b> (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.
<b>Library/media center labs</b>	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
<b>Mobile Computers (a.k.a. computers on wheels or COWs)</b>			
<b>Mobile workstations</b>	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.
<b>Mobile labs</b> (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 workstations, but serve more students at one time.	Same as for mobile workstations.
<b>Classroom Computers</b>			
<b>Classroom workstations</b> (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.
<b>Stand-alone classroom computer</b> (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 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 3 Issues That Shape the Environment for Using Technology and Teacher Responses and Responsibilities**

Description	Information Sources	Critical Teacher Responses
<b>Social Issues</b>		
Quality of life concerns	<i>Wall Street Journal</i> study on digital privacy: Search for "The Web's New Gold Mine: Your Secrets" at <a href="http://online.wsj.com">http://online.wsj.com</a>	Teach students how to keep their personal information private and protected
Fears about technology overuses	Search for <i>The New Atlantis</i> article, "The Myth of Multitasking" at <a href="http://www.thenewatlantis.com">http://www.thenewatlantis.com</a> Search for the <i>Science</i> study, "Multitasking Splits the Brain" at <a href="http://news.sciencemag.org">http://news.sciencemag.org</a> Search for <i>New York Times</i> series, "Your Brain on Computers" at <a href="http://www.nytimes.com">http://www.nytimes.com</a>	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 <i>eSchool News</i> article, "Survey Reveals Disconnect in Online Safety Education" at <a href="http://www.eschoolnews.com">http://www.eschoolnews.com</a> Search for <i>eSchool News</i> report, "Teens Using 'Digital Drugs' to Get High" at <a href="http://www.eschoolnews.com">http://www.eschoolnews.com</a>	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 <i>Education Week</i> blog post, "Back-to-School Social-Networking Policies" at <a href="http://www.edweek.org">http://www.edweek.org</a> Search for sample "networking policy" at <a href="http://www.leeschools.net">http://www.leeschools.net</a> See Cyberbullying Research Center (with updates on Cyberbullying laws) at <a href="http://www.cyberbullying.us">http://www.cyberbullying.us</a>	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 <i>New Scientist</i> article, "Introduction: Computer Viruses" at <a href="http://www.newscientist.com">http://www.newscientist.com</a> Search for article, "The Common Types of Computer Viruses" at <a href="http://www.spamlaws.com">http://www.spamlaws.com</a>	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
<b>Educational Issues</b>		
Lack of technology funding	Federal funding opportunities: <a href="http://www2.ed.gov/fund/landing.jhtml">http://www2.ed.gov/fund/landing.jhtml</a> Educational technology funding opportunities: <a href="http://www.technologygrantnews.com">http://www.technologygrantnews.com</a> Search for <i>Education Week</i> article, "Schools Combine Netbooks, Open Source" on how to make computing more affordable at <a href="http://www.edweek.org">http://www.edweek.org</a>	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: <a href="http://www.nochildleftbehind.com">http://www.nochildleftbehind.com</a>	Keep up to date on latest federal requirements
Debate over best practices with technologies	Partnership for 21st Century Skills website: <a href="http://www.p21.org">http://www.p21.org</a> Project Tomorrow surveys on technology uses in teaching: <a href="http://www.tomorrow.org">http://www.tomorrow.org</a>	Keep up-to-date on best practices for teaching 21st Century Skills

## Educational Technology in Context: The Big Picture

Description	Information Sources	Critical Teacher Responses
Reliance on distance education	Keeping Pace with K-12 Online Learning: <a href="http://www.kpk12.com">http://www.kpk12.com</a>	Demonstrate and model online learning methods and resources
<b>Cultural/Equity Issues</b>		
The Digital Divide	Read reports on mobile access and social media at the <i>Pew Internet and American Life Project</i> site at <a href="http://pewinternet.org">http://pewinternet.org</a> Search for the report, "Scaling the Digital Divide: Home Computer Technology and Student Achievement" at <a href="http://www.urban.org">http://www.urban.org</a>	Read latest reports on how to bridge the Digital Divide at <a href="http://www.digitaldivide.net">http://www.digitaldivide.net</a> 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 <a href="http://bayerfactsofscience.online-pressroom.com">http://bayerfactsofscience.online-pressroom.com</a>	Use best practices to encourage female and minority participation in STEM courses and careers
Students with special needs	Assistive technologies website: <a href="http://www.closingthegap.com">http://www.closingthegap.com</a> Universal Design for Learning website: <a href="http://www.cast.org">http://www.cast.org</a>	Keep updated on technologies that can be of use to solve problems for students with disabilities Use sites that show latest adaptive technologies
<b>Legal/Ethical Issues</b>		
Hacking	Search for <i>Education Week</i> article, "Tech-Savvy Students Hack Into School Computers" at <a href="http://www.edweek.org">http://www.edweek.org</a>	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 <a href="http://www.justice.gov">http://www.justice.gov</a> Review FEMA's online safety rules for kids at <a href="http://www.fema.gov/kids/on_safety.htm">http://www.fema.gov/kids/on_safety.htm</a> See the "Online Safety Guide" at <a href="http://kids.getnetwise.org">http://kids.getnetwise.org</a>	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 <i>New York Times</i> article, "Plagiarism Lines Blur for Students in Digital Age" at <a href="http://www.nytimes.com">http://www.nytimes.com</a> 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 <a href="http://www.copyright.gov">http://www.copyright.gov</a> Search for article, "Does Your Instructor Know It's You? Issues in Verifying Online Student Identities" at <a href="http://www.distance-education.org">http://www.distance-education.org</a>	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 <a href="http://www.networkworld.com">http://www.networkworld.com</a> Search for article, "Who Music Theft Hurts" with Piracy Statistics from the Recording Industry Association of America (RIAA) at <a href="http://www.riaa.com">http://www.riaa.com</a>	Educate students about software/music piracy laws and repercussions for breaking them

## 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 Finkelhor (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



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

**A**s 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 4.

### 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. NETS for Students are considered to be the basic skills that students—and their teachers—should meet. NETS for Teachers, which



SOURCE	TRACK	SELECTION
Accountability and the standards movement	<b>1</b>	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	<b>2</b>	As technology costs grow and education funds wane, policy makers ask, "How can we justify spending scarce education dollars on technology?"
The Digital Divide	<b>3</b>	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	<b>4</b>	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	<b>5</b>	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	<b>6</b>	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	<b>7</b>	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	<b>8</b>	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	<b>9</b>	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	<b>10</b>	Society's increasing dependence on technology to communicate information means that students must learn the skills to use information technologies effectively.



**Table 4** Links to Today's Educational Technology Skill Standards

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

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 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 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

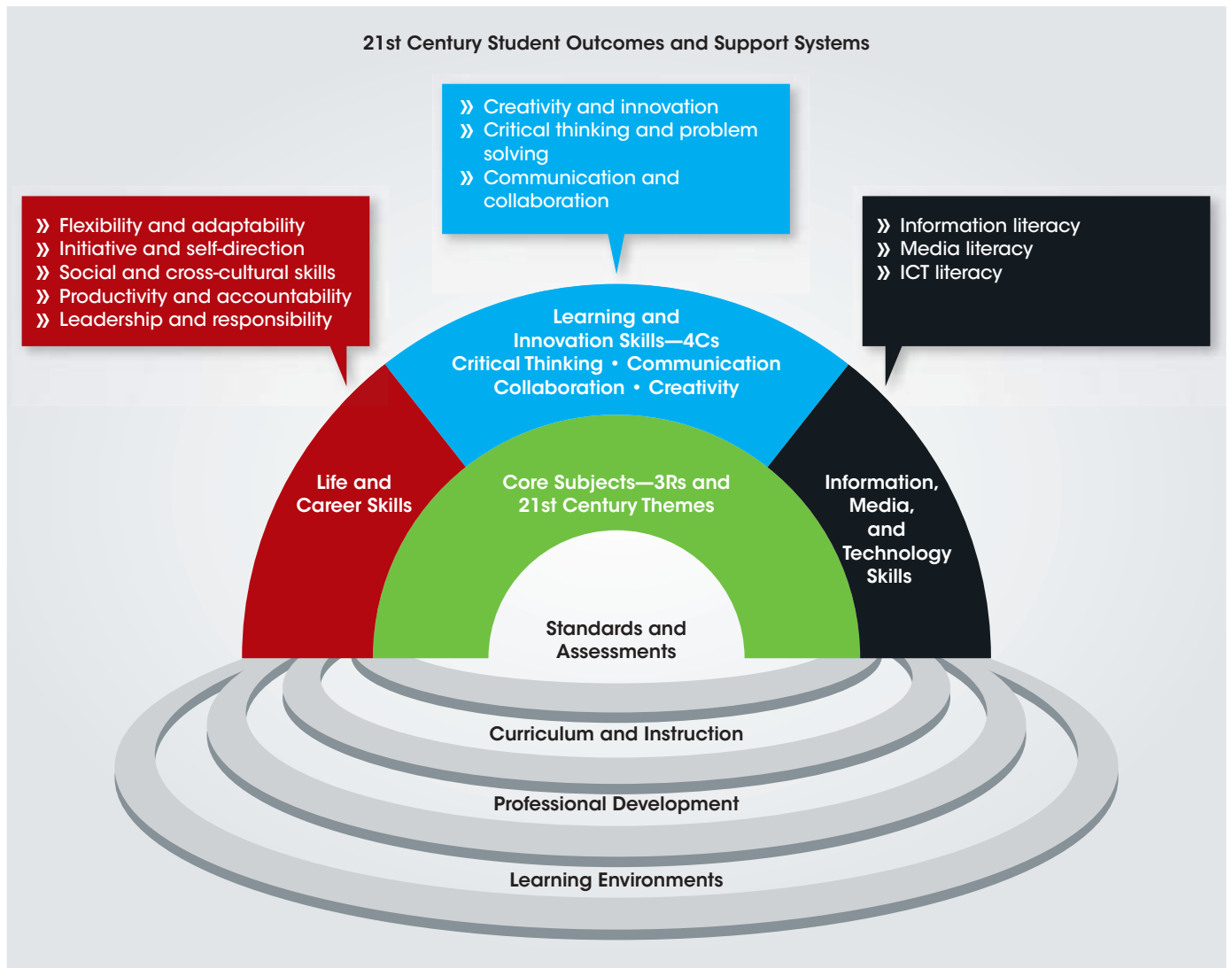
focuses on skills that teachers require to bring about three different levels of human capacity development: technology literacy, knowledge deepening, and knowledge creation. ICT is a term often used in place of the terms *instructional technology* and *educational technology*, especially outside the 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 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\\_kinderergarten\\_12/web\\_page\\_hosting\\_teacher\\_tools.htm](http://www.internet4classrooms.com/links_grades_kinderergarten_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.toppenreviews.com>.

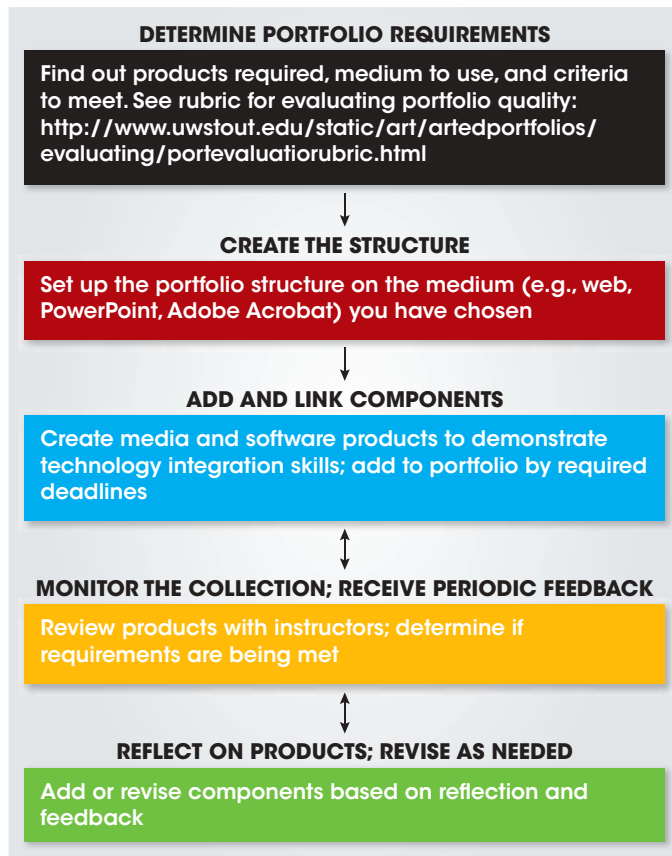
Figure 4 shows a suggested sequence to follow in creating an electronic portfolio. Also see Barrett's collection of portfolio resources at <http://electronicportfolios.com> for more advice on portfolio development.

## 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 4 Electronic Portfolios: How to Develop Them



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 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 5 Why Use Technology? A Summary Rationale Based on Problem Solving

<b>Problem 1: How to motivate and engage students?</b>
<ul style="list-style-type: none"> <li>» Gains learner attention</li> <li>» Supports manual operations during high-level learning</li> <li>» Illustrates real-world relevance through highly visual presentations</li> <li>» Engages students through production work</li> <li>» Connects students with audiences for their writing</li> <li>» Engages learners through real-world situations and collaborations</li> <li>» Provides support for working cooperatively</li> </ul>
<b>Problem 2: How to support students' learning needs?</b>
<ul style="list-style-type: none"> <li>» Supports effective skill practice</li> <li>» Helps students visualize underlying concepts in unfamiliar or abstract topics</li> <li>» Lets students study systems in unique ways</li> <li>» Gives access to unique information sources and populations</li> <li>» Supplies self-paced learning for accelerated students</li> <li>» Turns disabilities into capabilities</li> <li>» Saves time on production tasks</li> <li>» Grades and tracks student work</li> <li>» Provides faster access to information sources</li> <li>» Saves money on consumable materials</li> </ul>
<b>Problem 3: How to prepare students for future learning?</b>
<ul style="list-style-type: none"> <li>» The need for technological literacy</li> <li>» The need for information literacy</li> <li>» The need for visual literacy</li> </ul>

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 seen 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 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 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

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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 11), 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 5, 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, 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.

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# National Educational Technology Standards

## ► For Teachers

Effective teachers model and apply the National Educational Technology Standards for Students (NETS-S) as they design, implement, and assess learning experiences to engage students and improve learning; enrich professional practice; and provide positive models for students, colleagues, and the community. All teachers should meet the following standards and performance indicators. Teachers:

### 1. Facilitate and Inspire Student Learning and Creativity

Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments. Teachers:

- promote, support, and model creative and innovative thinking and inventiveness.
- engage students in exploring real-world issues and solving authentic problems using digital tools and resources.
- promote student reflection using collaborative tools to reveal and clarify students' conceptual understanding and thinking, planning, and creative processes.
- model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments.

### 2. Design and Develop Digital-Age Learning Experiences and Assessments

Teachers design, develop, and evaluate authentic learning experiences and assessments incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS-S. Teachers:

- design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity.
- develop technology-enriched learning environments that enable all students to pursue their individual curiosities and become active participants in setting their own educational goals, managing their own learning, and assessing their own progress.
- customize and personalize learning activities to address students' diverse learning styles, working strategies, and abilities using digital tools and resources.
- provide students with multiple and varied formative and summative assessments aligned with content and technology standards and use resulting data to inform learning and teaching.

### 3. Model Digital-Age Work and Learning

Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society. Teachers:

- demonstrate fluency in technology systems and the transfer of current knowledge to new technologies and situations.
- collaborate with students, peers, parents, and community members using digital tools and resources to support student success and innovation.
- communicate relevant information and ideas effectively to students, parents, and peers using a variety of digital-age media and formats.
- model and facilitate effective use of current and emerging digital tools to locate, analyze, evaluate, and use information resources to support research and learning.

### 4. Promote and Model Digital Citizenship and Responsibility

Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices. Teachers:

- advocate, model, and teach safe, legal, and ethical use of digital information and technology, including respect for copyright, intellectual property, and the appropriate documentation of sources.
- address the diverse needs of all learners by using learner-centered strategies and providing equitable access to appropriate digital tools and resources.
- promote and model digital etiquette and responsible social interactions related to the use of technology and information.
- develop and model cultural understanding and global awareness by engaging with colleagues and students of other cultures using digital-age communication and collaboration tools.

### 5. Engage in Professional Growth and Leadership

Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources. Teachers:

- participate in local and global learning communities to explore creative applications of technology to improve student learning.
- exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others.
- evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning.
- contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community.

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## ► For Students

### 1. Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

- apply existing knowledge to generate new ideas, products, or processes.
- create original works as a means of personal or group expression.
- use models and simulations to explore complex systems and issues.
- identify trends and forecast possibilities.

### 2. Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:

- interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- develop cultural understanding and global awareness by engaging with learners of other cultures.
- contribute to project teams to produce original works or solve problems.

### 3. Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

- plan strategies to guide inquiry.
- locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- process data and report results.

### 4. Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students:

- identify and define authentic problems and significant questions for investigation.
- plan and manage activities to develop a solution or complete a project.
- collect and analyze data to identify solutions and/or make informed decisions.
- use multiple processes and diverse perspectives to explore alternative solutions.

### 5. Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students:

- advocate and practice safe, legal, and responsible use of information and technology.
- exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- demonstrate personal responsibility for lifelong learning.
- exhibit leadership for digital citizenship.

### 6. Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

- understand and use technology systems.
- select and use applications effectively and productively.
- troubleshoot systems and applications.
- transfer current knowledge to learning of new technologies.

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# THEORY INTO PRACTICE

## FOUNDATIONS FOR EFFECTIVE TECHNOLOGY INTEGRATION

# THEORY INTO PRACTICE

## FOUNDATIONS FOR EFFECTIVE TECHNOLOGY INTEGRATION

A theme in [American education] is that natural, real-world simulations...are superior to the artificial, step-by-step methods of traditional schooling... Should students be immersed right away in complete situations that simulate real life...or should they first be provided with explicit modes of instruction that focus on small chunks deliberately isolated from the complexities of actual instruction?

E. D. Hirsch, *Classroom Research and Cargo Cults* (2002)



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### o u t c o m e s

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

1. Identify and describe three factors required for effective technology integration.
2. Analyze a given directed teaching method or technology integration model in order to identify the learning theorists and theories that gave rise to it.
3. Analyze a given constructivist teaching method or technology integration model in order to identify the learning theorists and theories that gave rise to it.
4. Analyze technology integration strategies in order to identify whether they reflect directed or constructivist approaches, or combinations of these.
5. Apply steps in each of the three phases of the Technology Integration Planning (TIP) Model to develop a sample classroom technology integration strategy.
6. Describe essential conditions to support effective classroom integration of technology.

### key terms

accommodation  
assimilation  
automaticity  
classical conditioning  
constructivism  
contingencies of reinforcement

directed instruction  
discovery learning  
disequilibrium  
enactive learning  
Gagné's Events of Instruction  
inert knowledge

inquiry-based learning  
learning hierarchies  
Likert scale  
long-term memory (LTM)  
mastery learning  
multiple intelligences theory



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## TECHNOLOGY INTEGRATION IN ACTION: THE ROLE OF CONTEXT

### STRATEGY A: PREPARING STUDENTS FOR STATE TESTS

One of Bill’s responsibilities as mathematics department chair was helping all teachers make sure their students did well on the mathematics portion of the state’s Test of Essential Skills for Success (TESS). Because students could not go on to high school unless they passed the TESS, Bill and the other math teachers were determined that every student in the school would pass the TESS-M, the math portion. They were also determined that they would not just “teach to the test.” They wanted the students to have a good grounding in math skills that would serve them well in their future education.

From practice test scores he had seen, Bill realized that there were too many students who needed help to provide individual coaches or tutors for each one, and he disliked the idea of making all students work on skills only some of them needed. At a school he had visited in another district, Bill had been impressed with how teachers relied on a computer-based system that included drills, tutorials, simulations, and problem-solving activities that they could access in their rooms or from the computer lab.

One of the benefits of the system was that students could take practice tests and teachers could get a list of skills with which they were having problems. Then the system would recommend specific activities, on and off the system, matched to each child’s needs. The activities ranged from practice in very basic math skills

to solving real-life problems that required algebra and other math skills. Bill persuaded his principal to purchase a year’s subscription to this system, and he and the other math teachers agreed on ways they would use it to supplement their classroom instruction.

That year, every student at the school passed the TESS-M. The math teachers agreed that the computer-based activities had played a key role in students’ preparation. They liked the way it helped them target students’ specific needs more efficiently while not overemphasizing test taking. Bill asked the principal to make the system a permanent part of the school’s budget.

### STRATEGY B: A SIMULATED FAMILY PROJECT

Mayda’s seventh-grade math students are usually fairly good at math skills; almost none of them has any trouble passing the state’s criterion-referenced test. However, she likes to do at least one ongoing project each year to show students how their math skills apply to real-life situations. She also wants them to learn to work together to solve problems, just as they would be doing in college and in work situations when they graduated.

The first activity she does at the beginning of each year is to have her students work in small groups to simulate “families.” They select a type of “job” their “wage earner” will have and create a monthly budget in a spreadsheet template she set up that shows income earned from an imaginary job versus estimated monthly

objectivism  
operant conditioning  
programmed instruction  
relative advantage  
rubric  
scaffolding

self-efficacy  
semantic differential  
sensory registers  
short-term memory (STM)  
situated cognition  
social activism theory

systems approaches to  
instructional design  
TPCK (TPACK)  
vicarious learning  
zone of proximal  
development (ZPD)



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expenses for each of them and for the “family.” To select jobs, the groups consult online newspaper Help Wanted sections to get an idea of what positions are available and how much they pay.

To estimate expenses, they look at online newspaper and real estate ads to see how much it costs to rent a house or an apartment in an area where they would like to live. Throughout the year, she gives each group unexpected expenses (e.g., the dog gets sick, the roof is leaking); the students must then adjust their spreadsheet budget to compensate for the extra expenses. If a group gets too far out of line with its budgeted expenses, she makes the students get a “loan,” which they do by researching available interest rates and adding a loan payment to their spreadsheet budgets that will pay off their “debt.”

Toward the end of the year, Mayda has students do estimated taxes on their earnings. Finally, they prepare a report using *PowerPoint* software that shows charts of their spending and what they learned about “making ends meet.” The students always tell her this is the most meaningful math activity they have ever done.

## OVERVIEW OF FACTORS IN SUCCESSFUL TECHNOLOGY INTEGRATION

As illustrated by the Technology Integration in Action example that begins this chapter, the answer to Hirsch’s question in the opening quote, “Which strategy works best?” is fundamental to understanding when technology works best. As Hirsch himself acknowledged later in his article, the answer is, “The right method depends on the situation.” Just as different learning needs call for different teaching methods, effective technology integration depends on a well-planned match of needs with tools and strategies, as well as classroom conditions that support them.

This chapter describes three factors that help ensure effective technology integration strategies, as depicted in Figure 1.

- » **Learning theory foundations**—Since learning theories should inform teaching strategies, it is important to begin with a look at two very different, competing theories of how learning should take place and examine how various kinds of technology integration strategies were derived from them.
- » **Integration planning model and Tech-PACK**—For the procedural and “people” issues involved in technology integration, we look to the steps of a three-phased Technology Integration Planning (TIP) Model and how teachers can assess the knowledge they require to plan and implement given technology-based lessons.
- » **Essential conditions for integration**—The International Society for Technology in Education (ISTE)

emphasizes that technology-based strategies work best when optimal conditions are in place to support them. Thus, a review of these conditions is the final piece in the foundation.

## OVERVIEW OF LEARNING THEORY FOUNDATIONS FOR TECHNOLOGY INTEGRATION

Prior to about 1980, there seemed little question about the appropriate instructional role for technology, particularly computer technology. According to respected writers of the time (Taylor, 1980), there were three acceptable roles: computers as tools to support learning (e.g., word processing, calculations), as tutors to deliver instruction (e.g., drill and practice, tutorials), and as “tutees” (e.g., learning to program computers).

However, as technology became more capable and complex, society changed in response, and with those changes came differing views of education and appropriate teaching strategies. This section will describe two very different perspectives on effective teaching and the conditions and learning theories that gave rise to them. These perspectives and theories pave the way for the technology integration strategies discussed later in this chapter.

### Two Perspectives on Effective Instruction

In the past, educational goals reflected society’s emphasis on the need for basic skills—such as reading, writing, and

## FIGURE 1 Factors Required for an Enlightened Approach to Technology Integration



arithmetic—and an agreed-on body of information considered essential for everyone. Many educators now believe that the world is changing too quickly to define education in terms of specific information or skills; they believe it should focus instead on more general capabilities, such as “learning to learn” skills, that will help citizens cope with inevitable technological change. The emphasis on learning and innovation skills and critical thinking and problem solving in the 21st Century Student Outcomes created by the Partnership for 21st Century Skills (P21) reflect this belief.

While everyone seems to agree that changes in our educational methods are needed to respond to modern challenges, not everyone agrees on which strategies will serve today’s educational goals. One view, **directed instruction**, where teachers transmit a pre-defined set of information to students through teacher-organized activities, is based on **objectivism**, a belief system grounded primarily in behaviorist learning theory and the information-processing branch of the cognitive learning theories. The other view, **inquiry-based learning**, in which learners generate their own knowledge through experiences and teachers serve only as facilitators, is based on **constructivism**, which evolved from other branches of thinking in cognitive learning theory. A few technology applications, such as drill and practice and tutorials, are associated only with directed instruction; most others (problem solving, multimedia production,

web-based learning) can inform either directed instruction or constructivist teaching and learning, depending on how they are used.

This text is based on the premise that there are meaningful roles for both directed instruction and constructivist strategies and the technology applications associated with them. Both can help teachers and students meet the many and varied requirements of learning in today’s Information Age society.

## Theories Underlying Directed and Constructivist Teaching Strategies

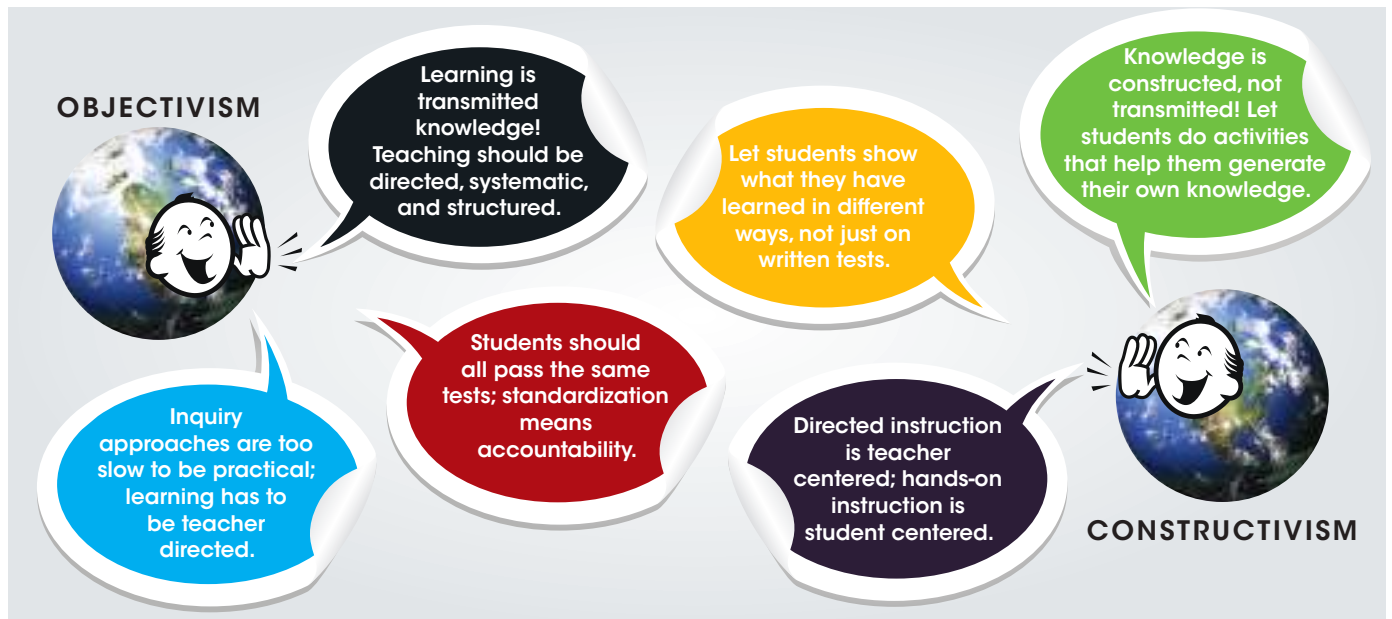
Like most people with radically different views on the same issue, **objectivists** and **constructivists** frequently use different terms to describe essentially the same things. Sfard (1998) says that differences in the language used to describe learning spring from two different metaphors used for learning: the acquisition metaphor and the participation metaphor. She notes that “the acquisition metaphor is likely to be more prominent in older writings, [and] more recent studies are often dominated by the participation metaphor” (p. 5). These differences in language signal fundamental differences in thinking about how learning takes place and how we can foster it. Figure 2 gives examples of how educators use different terms to describe the same things because of their differing views.

How did these differences come about? It is important to recognize that both people who espouse directed instruction and those who take constructivist approaches are attempting to identify what Gagné (1985) called the conditions of learning, or the “sets of circumstances that obtain when learning occurs” (p. 2). Both approaches are based on the work of respected learning theorists and psychologists who have studied both the behavior of human beings as learning organisms and the behavior of students in schools and classrooms.

Educators’ views diverge, however, in the ways they define learning, how they identify the conditions required to make learning happen, and how they perceive the problems that interfere most with learning. They disagree because they attend to different philosophies and learning theories and, consequently, they take different perspectives on improving current educational practice.

The two sets of learning theories have very different underlying epistemologies (beliefs about the nature of human knowledge as well as how to develop it). Constructivists (those who espouse inquiry-based methods based on cognitive, developmental, and generative/discovery theories) and objectivists (those who espouse directed methods based on behavioral, cognitive-behavioral, and information-processing theories) come from separate and different epistemological

**FIGURE 2** Objectivism and Constructivism: How Are We Different?



## Hot Topic Debate

### IS CONSTRUCTIVISM A “FAILED APPROACH?”

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.

the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching,” (see [http://www.cogtech.usc.edu/publications/Kirschner\\_Sweller\\_Clark.pdf](http://www.cogtech.usc.edu/publications/Kirschner_Sweller_Clark.pdf)) Kirschner, Sweller, and Clark (2006) say that inquiry-based methods are a “failed approach” (p. 84) and that, to achieve best results, all instruction should be highly structured and systematically delivered. What evidence in research or practice can you cite to support or refute their position? (See especially the article in the same journal by Kuhn (2007), “Is Direct Instruction an Answer to the Right Question?”)

In their *Educational Psychologist* article, “Why Minimal Guidance During Instruction Does Not Work: An Analysis of

“planets,” although both nurture many different tribes or cultures (Molenda, 1991; Phillips, 1995). The characteristics and theoretical origins of these philosophical differences can be summarized in the following way:

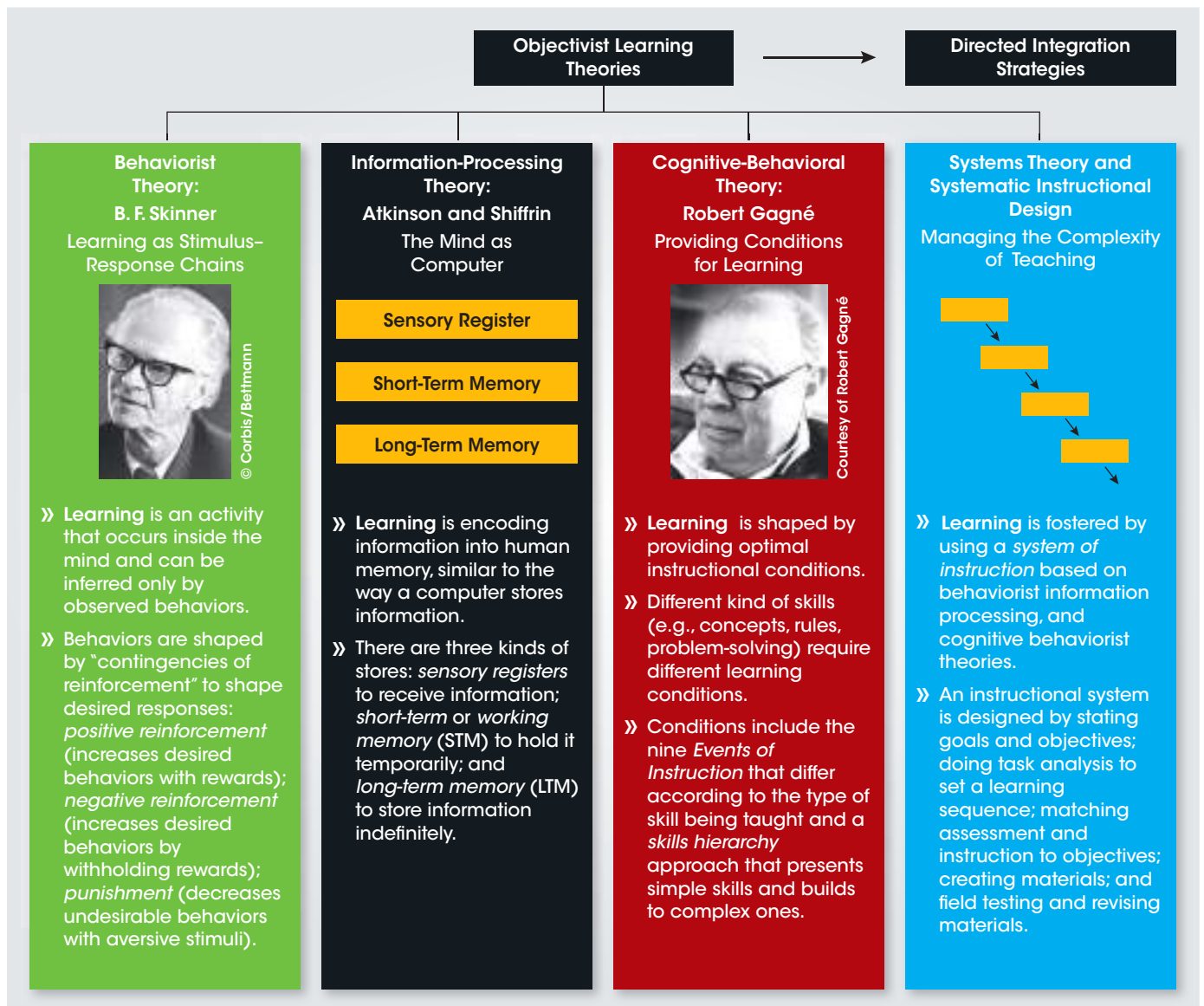
- » **Objectivists**—Knowledge has a separate, real existence of its own outside the human mind. Learning happens when this knowledge is transmitted to people and they store it in their minds.
- » **Constructivists**—Humans construct all knowledge in their minds by participating in certain experiences. Learning occurs when one constructs both mechanisms for learning and one’s own unique version of the knowledge, colored by background, experiences, and aptitudes.

The following sections will describe the theories that underlie these belief systems.

## LEARNING THEORY FOUNDATIONS OF DIRECTED INTEGRATION MODELS

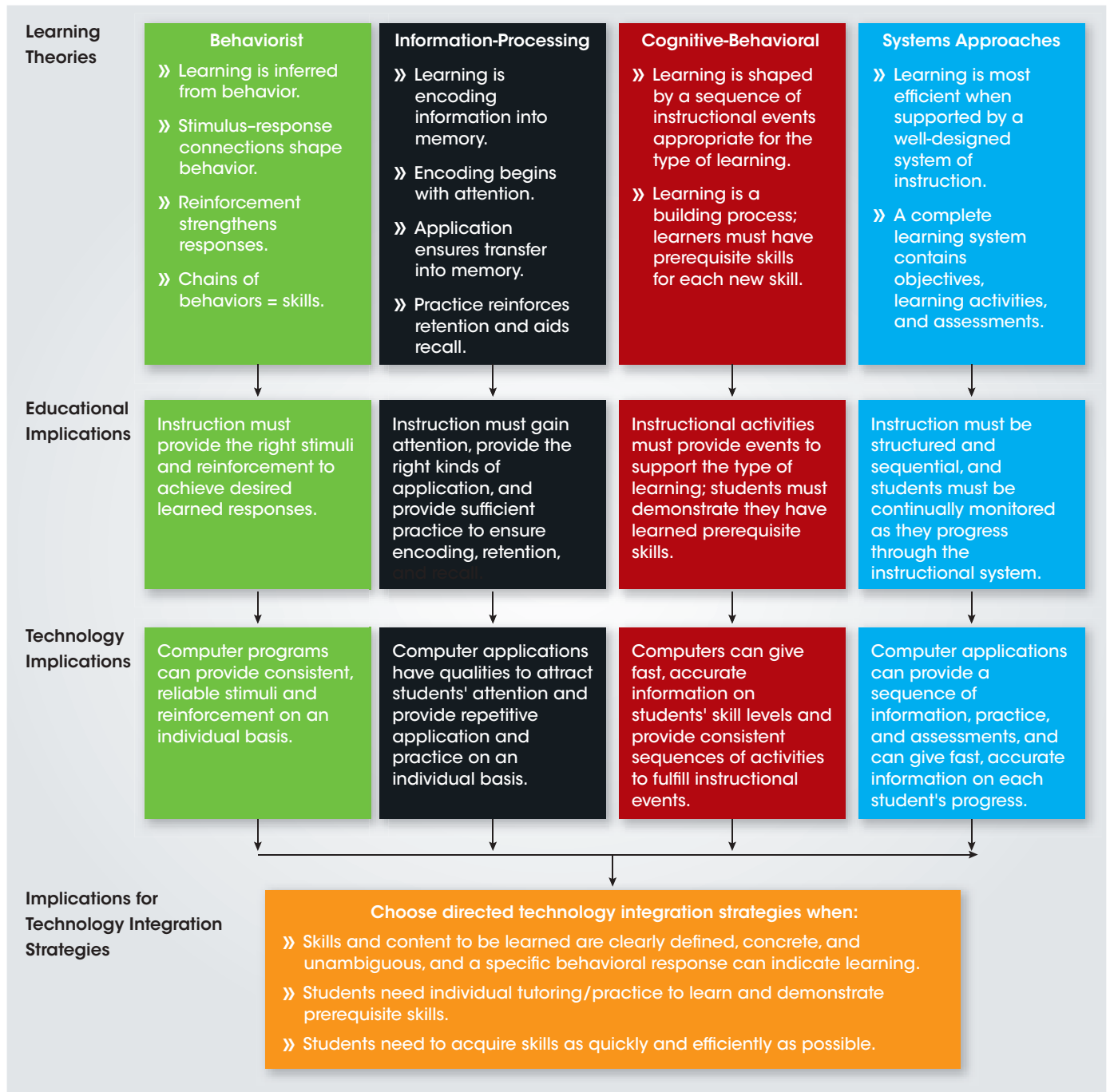
Objectivists attend to concepts that evolved from behavioral, information-processing, and cognitive-behaviorist learning theories and the **systems approaches to instructional design** that were based on them. The basic concepts associated with these theories are described briefly here and summarized in Figure 3. Their implications for

**FIGURE 3** Theories Underlying Directed Technology Integration Strategies





**FIGURE 4** How Objectivist Learning Theories Lead to Directed Technology Integration Strategies



education and for technology integration are summarized in Figure 4.

### Behaviorist Theories

Called by some “the most influential psychologist of the 20th century” (Eggen & Kauchak, 2010, p. 167), B. F. Skinner’s concepts built on the **classical conditioning**

concepts of Russian physiologist Ivan Pavlov, which viewed learning as involuntary physical responses to outside stimuli (e.g., dogs salivate at the sight of a dog food can). Skinner said that with **operant conditioning**, people can have voluntary mental control over their responses and that the consequences of their past actions can act as stimuli in shaping future behaviors. He said that since learning processes occur inside the mind and we cannot see them directly, learning

can only be inferred by observing behaviors. He believed learned behaviors could be shaped by **contingencies of reinforcement** set up to shape desired responses: Positive reinforcement (e.g., praise for correct answers) and negative reinforcement (e.g., avoiding detention by being on time to school) increase behaviors, while punishment decreases behaviors (e.g., refraining from violence after being expelled for fighting). Skinner used reinforcement principles to develop **programmed instruction** techniques for training and instruction in which content is presented in discrete steps that the learner completes in a set sequence. Later, Benjamin Bloom used Skinner's principles in his **mastery learning** concepts, an approach that gave students a sequence of objectives that defined mastery of a subject. Students had to pass tests on each objective to demonstrate they had mastered a skill before proceeding to the next one. Today, many classroom management techniques are based on behavior modification principles derived from Skinner's reinforcement principles (e.g., students get praise or an entertaining graphic for correct answers; students memorize important basic skills by practicing to increase the frequency of their correct responses to problems).

## Information-Processing Theories

Because many people found Skinner's "learning as behavior-shaping concepts" insufficient to guide instruction, the first cognitive (as opposed to behavioral) learning theorists began to hypothesize *processes inside the brain* that allow human beings to learn and remember. Much of the work of the information-processing theorists is based on a model of memory and storage proposed by Atkinson and Shiffrin (1968), who said that the brain contains three kinds of memory, or "stores," to process information—much like a computer. **Sensory registers** receive information a person senses through receptors (i.e., eyes, ears, nose, mouth, and/or hands). After a second or so, the information is either lost or transferred to **short-term memory (STM)**, or working memory. STM holds new information for about 5 to 20 seconds. Unless it is processed or practiced in a way that causes it to be encoded or transferred to **long-term memory (LTM)**, it also is lost. LTM can hold information indefinitely, but for new information to be transferred to LTM, it must be linked in some way to prior knowledge already in LTM.

Common teaching practices based on these concepts include the use of (1) interesting questions and eye-catching material to help students pay attention to a new topic; (2) providing mnemonic devices (e.g., saying that HOMES stands for the first letters in the five Great Lakes; (3) instructions that point out important points in new material to help students remember them by linking them to

information they already know; (4) providing visual explanations of abstract concepts; and (5) practice exercises to help transfer information from STM to LTM. Guidelines for enhancing attention, encoding, and storage processes include Ausubel's "top-down" approach, in which "advance organizers" or topic overviews give students mental frameworks on which to "hang" new information. Computer programs provide ideal environments for the highly-structured cueing, attention-getting, visualization, and practice features that information-processing theorists found so essential to learning.

## Cognitive-Behavioral Theory

An educational psychologist who translated principles from behavioral and information-processing theories into practical instructional strategies for teachers and trainers, Robert Gagné used research on information-processing models of learning to derive guidelines for arranging optimal "conditions of learning." Guidelines included **learning hierarchies** or "bottom-up" approaches, in which students learn lower order or prerequisite skills first (e.g., multiplication skills required to learn long-division skills) and build on them, and **Gagné's Events of Instruction** for several types of learning. (See Table 1.) Gagné, Wager, and Rojas (1981) showed how these Events of Instruction could be used to plan lessons using each kind of instructional software (drill, tutorial, simulation). They said that only a tutorial could "stand by itself" and accomplish all of the necessary Events of Instruction; the other kinds of software required teacher-led activities to accomplish events before and after software use.

## Systems Approaches: Instructional Design Models

These methods have their roots in the collaborative work of educational psychologists Robert Gagné and Leslie Briggs, who created a way to apply principles learned from military and industrial training to developing curriculum and instruction for schools. **Systems approaches to instructional design** were rooted in the belief that learning was most efficient when it was supported by a carefully designed system of instruction. Gagné promoted instructional task analysis to identify required learning hierarchy subskills and conditions of learning for them. Briggs offered systematic methods of designing training programs to save companies time and money in training their personnel.

When combined, these areas of expertise became a set of step-by-step processes known as a systems approach to instructional design, or systematic instructional design, which came into common use in the 1970s and 1980s. Other names associated with this era include Robert Mager

**Table 1** Gagné’s Events of Instruction Related to Mental Processes Involved in Learning

Instructional Event	Relation of Learning Process
1. Gaining attention	<i>Reception</i> of patterns of neural impulses
2. Informing the learner of the objective	Activating a process of <i>executive control</i>
3. Stimulating recall of prerequisite learning	<i>Retrieval</i> of prior learning to working memory
4. Presenting the stimulus material	Emphasizing features for <i>selective perception</i>
5. Providing learning guidance	<i>Semantic encoding</i> ; cues for <i>retrieval</i>
6. Eliciting the performance	Activating <i>response organization</i>
7. Providing feedback about performance correctness	Establishing <i>reinforcement</i>
8. Assessing the performance	Activating <i>retrieval</i> ; making <i>reinforcement</i> possible
9. Enhancing retention and transfer	Providing cues and strategies for <i>retrieval</i>

(instructional objectives), Glaser (criterion-referenced testing), Cronbach and Scriven (formative and summative evaluation), David Merrill (component display theory), and Charles Reigeluth (elaboration theory). Since instructional design results in a highly structured sequence of instruction, computer tutorials and self-paced distance learning courses offer ideal delivery systems for instructional design through these approaches.

## Teaching Methods and Technology Integration Strategies That Reflect Objectivist Theories

**Directed teaching methods.** A considerable body of research indicates that directed methods work well for addressing certain kinds of teaching/learning problems. For example, Kirschner, Sweller, and Clark (2006) argue that direct instruction is more effective and efficient than minimally guided instruction when learners do not have enough prior knowledge to be self-guided. They state that minimally guided instruction ignores the fundamentals of human cognition and overloads working memory; as such, minimal guidance during instruction is ineffective in altering long-term memory (i.e., learning). Kirschner et al. cite a large body of literature that supports their arguments (pp. 79–83), and other scholars echo their claims. Carnine, Silbert, and Kameenui (1997) and Stein, Silbert, and Carnine (1997) determined that directed drill and practice can help teach basic reading and mathematics skills. Spence and Hively (1993) note that increased fluency practice supports precision teaching of basic reading and math skills to young learners. Mallott (1993) found that using reinforcement principles

can improve the study habits and achievement of college students, and Carnine (1993) asserts that structured, teacher-directed techniques were effective in teaching problem-solving and higher order thinking skills to at-risk students. Finally, Hirsch (2002) comments that “one minute of explicit (directed) learning can be more effective than a month of implicit (exploratory) learning.”

**Directed models of technology integration.** Pure objectivists focus primarily on technology integration strategies for systematically designed, structured learning products such as drills, tutorials, and integrated learning systems (ILSs). When they do use other materials that have no innate structure, such as simulations and problem-solving software, integration strategies are very structured, providing a step-by-step sequence of learning activities matched to specific performance objectives. When objectivists evaluate these products, they typically look for a match among objectives, methods, and assessment strategies and how well they help teachers and students meet curriculum standards. To reflect objectivist principles, materials and integration strategies must have clearly defined objectives and a set sequence for their use.

## LEARNING THEORY FOUNDATIONS OF CONSTRUCTIVIST INTEGRATION MODELS

Constructivist beliefs and methods were derived from a combination of concepts in social learning, scaffolding, stages of development, and multiple intelligences theories.

The basic concepts of these theories are described briefly here and summarized in Figure 5. Their implications for education and for technology integration are summarized in Figure 6.

## Social Activism Theory

An early proponent of racial equality and women's suffrage, John Dewey's radical activism shaped his beliefs about education. Identified closely with the Progressive Education reform initiative popular in the first half of the 1990s, many of his principles of education were in direct opposition to those of that period. Dewey deplored standardization and believed that curriculum should arise from students' interests. He also believed that curriculum topics should be integrated, rather than isolated, since teaching isolated topics prevented learners from grasping the whole of knowledge. He felt that education is growth, rather than an end in itself and that the common view that education is preparation for work separated society into social classes.

Instead, Dewey believed education should be a way of helping individuals understand their culture and should develop their relationship to and unique roles in society. Dewey's **social activism theory** was based on the belief that social consciousness was the ultimate aim of all education, and learning was useful only in the context of social experience. He found reading and mathematics had become ends in themselves, disconnected from any meaningful social context. Dewey believed that learning should be hands-on and experience-based, and that meaningful learning resulted from students working together on tasks related to their interests. Though considered by many to be the Grandfather of Constructivism, Dewey also advocated a merging of "absolutism" and "experimentalism," just as this chapter calls for combining directed and constructivist methods. Although he probably would deplore the current standards movement and the use of high-stakes testing programs, today's interdisciplinary curriculum and hands-on, experience-based learning are in tune with Dewey's lifelong message.

## Social Cognitive Theory

The work of Albert Bandura in the 1950s and 1960s was very much in keeping with Dewey's views of learning as a social process, but Bandura did pioneering research to show how this learning occurred. Bandura said that learning was "an information processing activity" that involved "reciprocal interactions among behaviors, environmental variables, and personal factors such as cognitions" (Schunk, 2008, p. 79). He felt that, contrary to the behavioral theories of reinforcement that were popular at that time,

students learned a great deal through observation (which he called **vicarious learning**), rather than through their actions (which he called **enactive learning**). Bandura found, for example, that one of the most powerful ways students learned was through observing the behaviors modeled by those around them.

He also found there was a difference between learning (acquiring new information or concepts) and performance (demonstrating what is learned); students often learned information and concepts in social settings that they did not reflect in any behavior. Though he acknowledged that enactive learning was learning from one's own actions, his ideas differed from Skinner's view that behavior changed automatically (i.e., without intention) as a result of reinforcement. Instead, Bandura found that it was students' beliefs and judgments as social beings that determined whether or not their actions changed; their internal cognitive processes shaped their actions, rather than external consequences resulting from reinforcement.

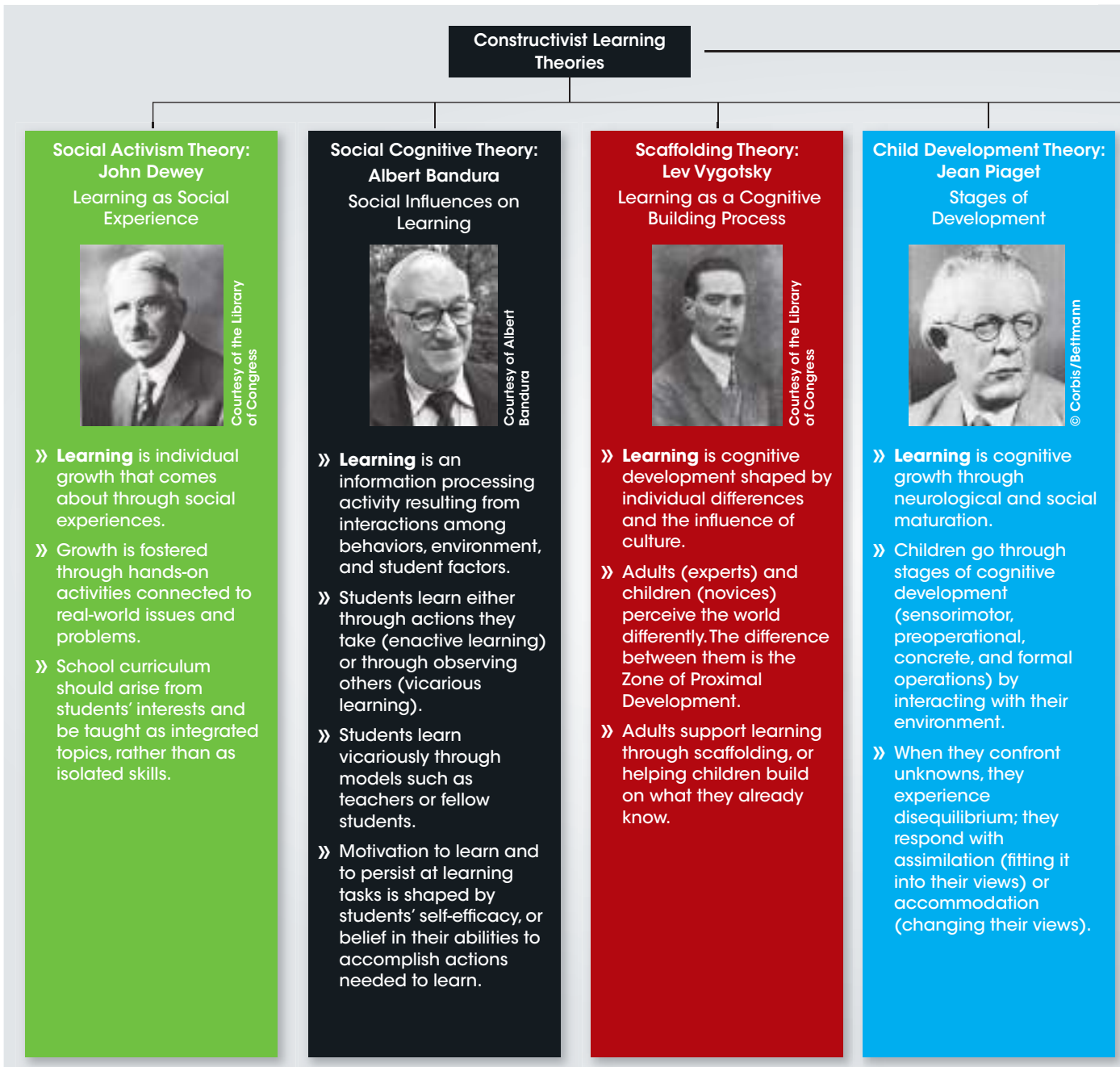
Motivation to learn also played a central role in Bandura's social cognitive theory. He found that students who were innately capable sometimes did not learn because they lacked **self-efficacy**, or belief in their abilities to accomplish the actions necessary to learn. Self-efficacy beliefs can be shaped by teachers and others and can affect whether or not students even try to learn, as well as how long they persist at learning tasks. Schunk (2008) reported a study that showed students' self-efficacy increasing from self-modeling, or watching videos of their own successful performance. Self-efficacy differs from self-concept in that self-concept is a general self-perception of one's overall abilities; self-efficacy is belief specific to a certain area of learning.

## Scaffolding Theories

Until the end of the Cold War in the 1990s, the writings of Russian philosopher and educational psychologist Lev Semenovitch Vygotsky had more influence on educational theory and practice in the United States than they did in his own country. His landmark book, *Pedagogical Psychology*, written in 1926, was not published in Russia until 1991 (Davydov, 1995). Since he viewed learners as individuals rather than as part of a "collective," his educational concepts were threatening to a communistic state but found a warm reception in a democracy. He felt that how children learn and think derives directly from the culture around them. An adult perceives things much differently than a child does, but this difference decreases as children translate their social views into personal/psychological views.

Vygotsky used the term **zone of proximal development (ZPD)** to refer to the difference between adult/expert

**FIGURE 5** Theories Underlying Inquiry-Based Technology Integration Strategies



and child/novice levels of cognitive functioning. He felt that teachers could provide good instruction by finding out where each child was in his or her development and building on the child's experiences, a process he called **scaffolding**. Ormrod (2001) said that teachers promote students' cognitive development by presenting some classroom tasks that "they can complete only with assistance, that is, within each student's zone of proximal development" (p. 59). Many visual technology tools, from video-based scenarios to virtual reality, are designed to scaffold students' understanding

through graphic examples and real-life experiences relevant to their individual needs.

### Child Development Theory

Jean Piaget referred to himself as a "genetic epistemologist," or a scientist who studies how knowledge begins and develops in individuals. He believed that, while the ages at which children mature vary somewhat, all children go through four stages of cognitive development. Each of these stages,



increased self-control, and the ability to delay gratification, but they cannot do conservation tasks (recognizing that shape is not related to quantity). At the operational stage (7–11 years), they increase abstract reasoning, can generalize from concrete experiences, and can do conservation tasks. Finally, at the formal operations stage (12–15 years), they form and test hypotheses, organize information, and reason scientifically; they can show results of abstract thinking with symbolic materials (e.g., writing, drama).

Piaget believed children develop through these stages by interacting with their environment. When they confront new and unfamiliar features of their environment that do not fit with their current views of the world, they experience “**disequilibrium**.” They learn by fitting the new experiences into the existing view of the world (i.e., **assimilation**) or by changing their views of the world to incorporate the new experiences (i.e., **accommodation**).

He felt that children are active and motivated learners whose knowledge of the world becomes more integrated and organized over time. Although Piaget himself repeatedly expressed a lack of interest in how his work applied to school-based education, calling it “the American question,” his pupil, MIT mathematician Seymour Papert (1980), used Piaget’s theories as the basis of his work with Logo, a language designed to let young students solve design problems using an on-screen “turtle.” This environment provided the vital link that Papert felt would allow children to move more easily from the concrete operations of earlier stages of Piaget’s hypothesis to more abstract (formal) operations. Papert’s 1980 book, *Mindstorms*, challenged then-current instructional goals and methods for mathematics and became the first constructivist statement of educational practice with technology.

## Discovery Learning

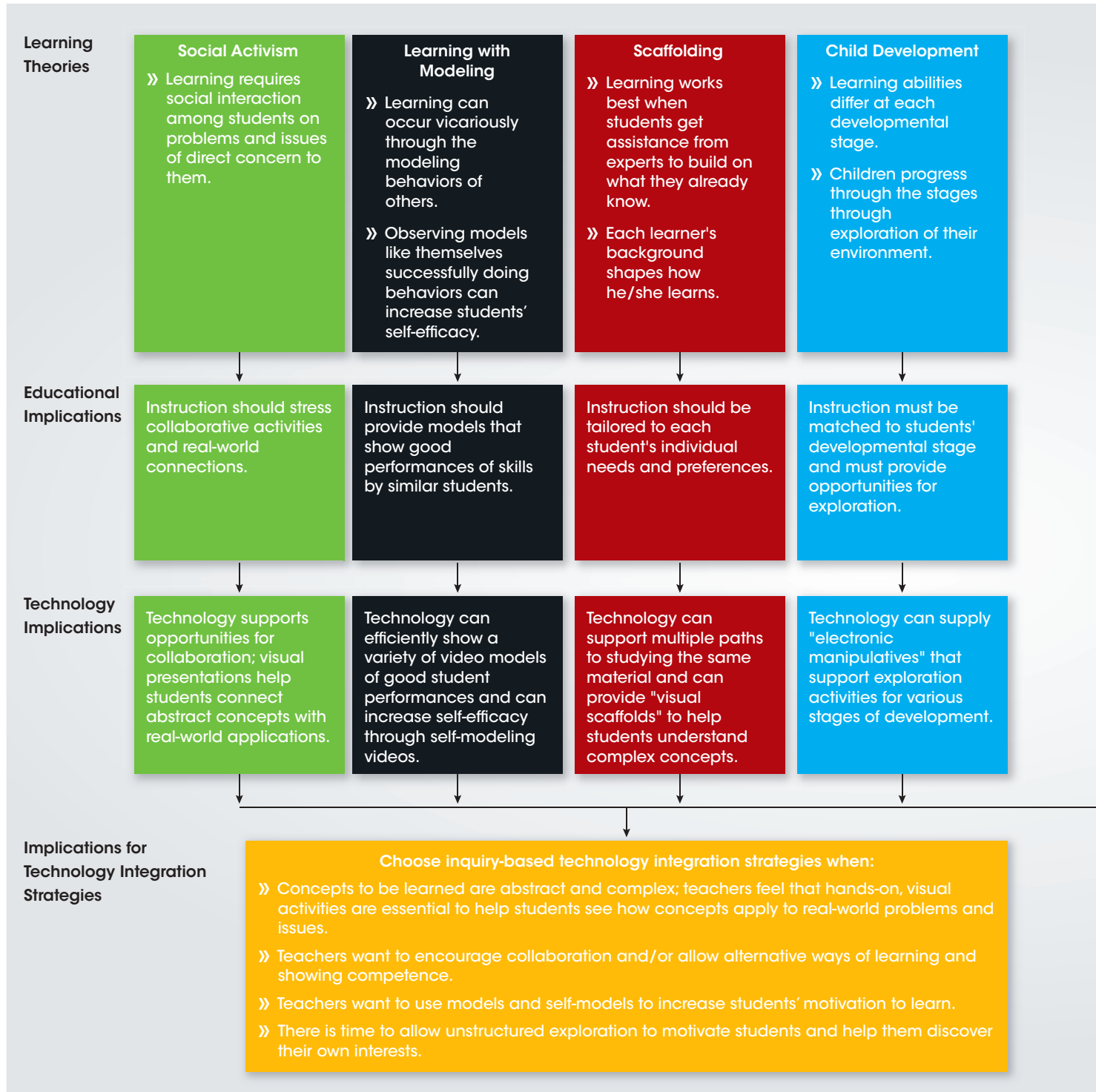
Some of the principles associated with educational theorist Jerome Bruner seem to coincide with those of Vygotsky and Piaget. Like Piaget, Bruner believed children go through various stages of intellectual development. But unlike Piaget, Bruner supported intervention. He was primarily concerned with making education more relevant to student needs at each stage, and he believed that teachers could accomplish this by encouraging active participation in the learning process.

Active participation, he felt, was best achieved by providing **discovery learning** environments that would let children explore alternatives and recognize relationships between ideas (Bruner, 1973). Bruner felt that students were more likely to understand and remember concepts they had discovered in the course of their own exploration. However, research findings have yielded mixed results for discovery

he felt, occurs only after certain genetically-controlled neurological changes and that all children develop higher reasoning abilities in the same sequence.

The sequence of development Piaget identified begins with the sensorimotor stage (birth–2 years), in which children explore the world around them through their senses and motor activity. Then they move on to the preoperational stage (2–7 years), in which they develop speech and symbolic activities (e.g., drawing objects, pretending, imagining), numerical abilities (e.g., assigning numbers and counting),

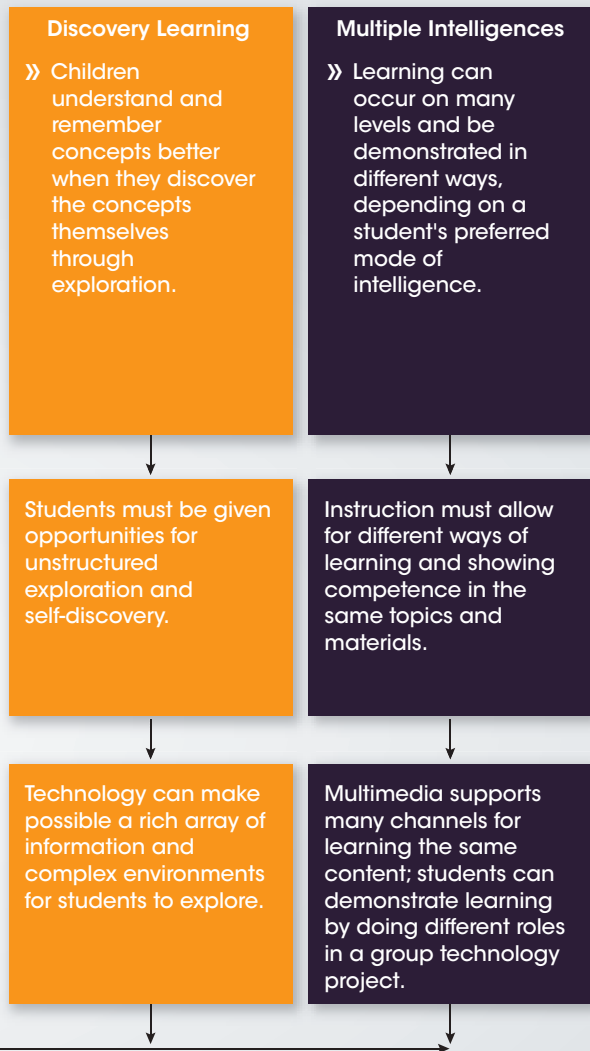
**FIGURE 6** How Constructivist Learning Theories Lead to Inquiry-Based Technology Integration Strategies



learning, and the relatively unstructured methods recommended by Bruner have not found widespread support. Teachers have found that discovery learning is most successful when they provide some structured experiences first.

### Multiple Intelligences Theory

The only theory that attempts to define the role of intelligence in learning, Gardner's work (Gardner, 1989) is based



different and relatively independent types of intelligence (see list in Figure 5). According to Gardner's theory, IQ tests (which tend to stress linguistic/logical-mathematical abilities) cannot judge all students' ability to learn, and traditional academic tasks may not reflect true ability. This theory supports doing group work on multimedia products, assigning students group roles based on their type of intelligence (e.g., those with high interpersonal intelligence are project coordinators, those with high logical-mathematical ability are technical experts, and those with spatial ability are designers).

## Teaching Methods and Technology Integration Strategies That Reflect Constructivist Theories

As Figure 6 illustrates, constructivist methods are designed to make learning more visual and experiential and to allow students more flexibility in how they learn and demonstrate competence. These qualities were designed to address a problem John Seely Brown called **inert knowledge**, a term introduced by Whitehead in 1929 to mean skills that students learned but did not know how to transfer later to problems that required them (Brown, Collins, & Duguid, 1989). Brown said that inert knowledge resulted from learning skills in isolation from each other and from real-life application; thus, he advocated cognitive apprenticeships, or activities that called for authentic problem solving, that is, solving problems in settings that are familiar and meaningful to students (CTGV, 1990). These ideas were based on the theories of Dewey, Bandura, Vygotsky, Piaget, and Bruner.

The first technology integration strategies based on these ideas were Papert's Logo-supported "microworlds," in which children worked with a very visual programming language to create on-screen designs. Later, other technology-based materials, such as the Jasper Woodberry Problem Solving Series, videodisc-based mathematics materials created by the now-disbanded Cognition and Technology Group at Vanderbilt (CTGV), and more recently, programs such as GeoThentic, were designed to provide learning environments that reflected **situated cognition**, or instruction anchored in experiences that learners considered authentic because they emulated the behavior of adults. These kinds of materials were intended to assist teachers in helping students build on or "scaffold" from experiences they already had to generate their own knowledge in an active, hands-on way, rather than receiving it passively. Today's constructivist integration strategies often focus on having students use data-gathering tools (e.g., mobile technologies) to study problems and issues in their

on Guilford's pioneering work on the structure of intellect (Eggen & Kauchak, 2004) and Sternberg's view of intelligence as influenced by culture (Ormrod, 2011). Gardner's **multiple intelligences theory** says there are at least eight





Technologies used in constructivist ways help students generate their own knowledge in an active, hands-on way, rather than receiving it passively.

Photo by W. Wiencke

locale, and on creating multimedia products to present their new knowledge and insights.

## TECHNOLOGY INTEGRATION STRATEGIES BASED ON DIRECTED AND CONSTRUCTIVIST THEORIES

Not surprisingly, educators who attend to objectivist theories have dramatically different ideas about curriculum and teaching/learning methods than those who espouse constructivist theories. Sometimes these differences of opinion have generated strident debate in the literature (Baines & Stanley, 2000; Educational Technology, 1991a, 1991b; Kirschner, Sweller, & Clark, 2006; Kuhn, 2007; Schmidt, Loyens, van Gog, & Paas, 2007). The debate continues because proponents of directed and constructivist views of learning focus on different kinds of problems (or different aspects of the same problems) confronting teachers and students in today's schools.

### Contrasting Views of Directed and Constructivist Proponents

The characteristics of each model are specifically targeted to certain teaching and learning problems (see Table 2). Directed models stress individual work using traditional teaching and learning methods because they are designed to address problems of accountability and quality assurance in our educational system. Constructivist models stress cooperative work and nontraditional exploration methods because they are designed to help students think on their own, work with diverse groups, and see the relevance of skills to their daily lives.

Table 2 also shows the contrast in assessment methods used to support directed and constructivist methods. Because directed strategies are also mastery learning strategies and teachers require clear, easily observable evidence that students have adequately mastered the skills, typical assessments for directed models are written objective tests (e.g., multiple choice, true/false, matching, short answer) and essays. Essays often are used to assess higher level performances, such as writing a composition. Measures are graded according to preset criteria for what constitutes acceptable performance. Very often, a software package includes tests and built-in criteria for passing them. Essays usually are graded with a criteria checklist or writing **rubric**, an instrument consisting of a set of elements that define important aspects of a given performance or product and ratings that describe levels of quality for each element.

Constructivists tend to eschew traditional assessment strategies as being too limiting to measure real progress in complex learning, and too removed from real-life tasks to be authentic. However, teachers recognize that even the most innovative activities require a reliable and valid means of measuring student progress. Commonly used assessment strategies are project assignments (e.g., web pages, multimedia products, desktop-published publications), self-report instruments (e.g., student-prepared journals or other descriptions), and portfolio entries.

It is because they have such different views of reality and theory bases that educators who espouse objectivist and constructivist beliefs take very different views of appropriate technology-based methods. Objectivists say constructivist methods are unrealistic; constructivists consider directed methods to be outmoded. Table 2 expands on these criticisms.

### The Future of Technology Integration: Merging the Two Approaches

Merging these two integration approaches in a way that will benefit both learners and teachers requires an open-minded view of what constitutes "appropriate instruction." Of course, the most effective approach will depend on the topics and problems that define the learning activity and individual learning needs.

Clearly, instructional problems identified by both objectivists and constructivists are common to most schools and classrooms, regardless of grade level, type of student, or content. Teachers will always use some directed instruction as the most efficient means of teaching required skills; teachers will always need motivating, cooperative learning activities to ensure that students want to learn and that they can transfer what they learn to problems they encounter.

**Table 2 A Comparison of Directed and Constructivist Models and the Problems They Address**

	Directed Instructional Models	Constructivist Models
<b>Teaching/Learning Methods</b>	<ul style="list-style-type: none"> <li>• Stress individualized work.</li> <li>• Have specific skill-based instructional goals and objectives; same for all students.</li> <li>• Teachers transmit a set body of skills and/or knowledge to students.</li> <li>• Students learn prerequisite skills required for each new skill.</li> <li>• Sequences of carefully structured presentations and activities to help students understand (process), remember (encode and store), and transfer (retrieve) information and skills.</li> <li>• Traditional teacher-directed methods and materials are used: lectures, skill worksheets.</li> </ul>	<ul style="list-style-type: none"> <li>• Stress group-based, cooperative work.</li> <li>• Have global goals such as problem solving and critical thinking; sometimes differ for each student.</li> <li>• Have students generate their own knowledge through experiences anchored in real-life situations.</li> <li>• Students learn lower order skills in the context of higher order problems that require them.</li> <li>• Learning through problem-oriented activities (e.g., “what if” situations); visual formats and mental models; rich, complex, learning environments; and learning through exploration.</li> <li>• Nontraditional materials are used to promote student-driven exploration and problem solving.</li> </ul>
<b>Instructional Needs and Problems Targeted</b>	<ul style="list-style-type: none"> <li>• <i>Accountability</i>: All students must meet required education standards to be considered educated.</li> <li>• <i>Individualization</i>: Help meet individual needs of students working at many levels.</li> <li>• <i>Quality assurance</i>: Quality of instruction must be consistently high across teachers and schools in various locations.</li> <li>• <i>Convergent thinking</i>: All students must have the same skills.</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Higher level skills</i>: All students must be able to think critically and creatively and solve problems.</li> <li>• <i>Cooperative group skills</i>: Help students learn to work with others to solve problems.</li> <li>• <i>Increase relevancy</i>: Students must have active, visual, authentic learning experiences that relate to their own lives.</li> <li>• <i>Divergent thinking</i>: Students must think on their own and solve novel problems as they occur.</li> </ul>
<b>Assessment Methods</b>	<ul style="list-style-type: none"> <li>• Traditional assessments (e.g., multiple choice, short answer) with specific expected responses; student products (e.g., essays) graded with checklists or rubrics.</li> </ul>	<ul style="list-style-type: none"> <li>• Nontraditional assessments (e.g., group products such as web pages, multimedia projects) with varying contents or portfolios; student products graded with self-report instruments, rubrics.</li> </ul>
<b>Criticisms</b>	<ul style="list-style-type: none"> <li>• Breaking topics into discrete skills and teaching them in isolation from each other is directed more at basic skills than at higher level ones; students cannot apply skills later (i.e., knowledge is inert).</li> <li>• Learning is repetitive and predictable: students often find it uninteresting and irrelevant; lack of motivation leads to lower achievement and higher dropout rates.</li> <li>• Not all topics lend themselves to directed approaches.</li> <li>• Students cannot solve novel problems or work cooperatively with others to solve problems.</li> </ul>	<ul style="list-style-type: none"> <li>• When students are allowed to demonstrate knowledge in varying ways, teachers cannot certify students’ individual skill levels, as required by today’s accountability standards.</li> <li>• Letting students generate their own knowledge is time-consuming and inefficient; students may lack prerequisite skills to handle constructivist problem-solving environments effectively.</li> <li>• Not all topics lend themselves to constructivist approaches.</li> <li>• Despite learning being anchored in authentic problems, students may not transfer skills to real-life situations.</li> </ul>

Proficient technology-oriented teachers must learn to combine directed instruction and constructivist approaches and to select technology resources and integration methods that are best suited to their specific needs.

These two ostensibly different views of reality will merge to form a new and powerful approach to solving some of the major problems of the educational system, each contributing an essential element of the new instructional formula. Hirsch (2002) believes that directed learning is best for providing a foundation of skills, while inquiry-based learning is probably best for developing global skills slowly over time. Other theorists and practitioners believe that constructivism will eventually dominate overall educational goals and objectives, such as learning to apply scientific methods, while systematic approaches will ensure that specific prerequisite skills are learned. This is not currently the case, however, especially in light of the tension between the constructivist view of reality and the current standards, testing, and teacher accountability movements.

It is important to recognize that each of the integration strategies described here addresses specific instructional needs identified by educational theorists and practitioners. Strategies are not employed because technology is the wave of the future or because students should occasionally use computers because it is good for them. This text advocates making a conscious effort to match technology resources to problems that educators cannot address in other, easier ways.

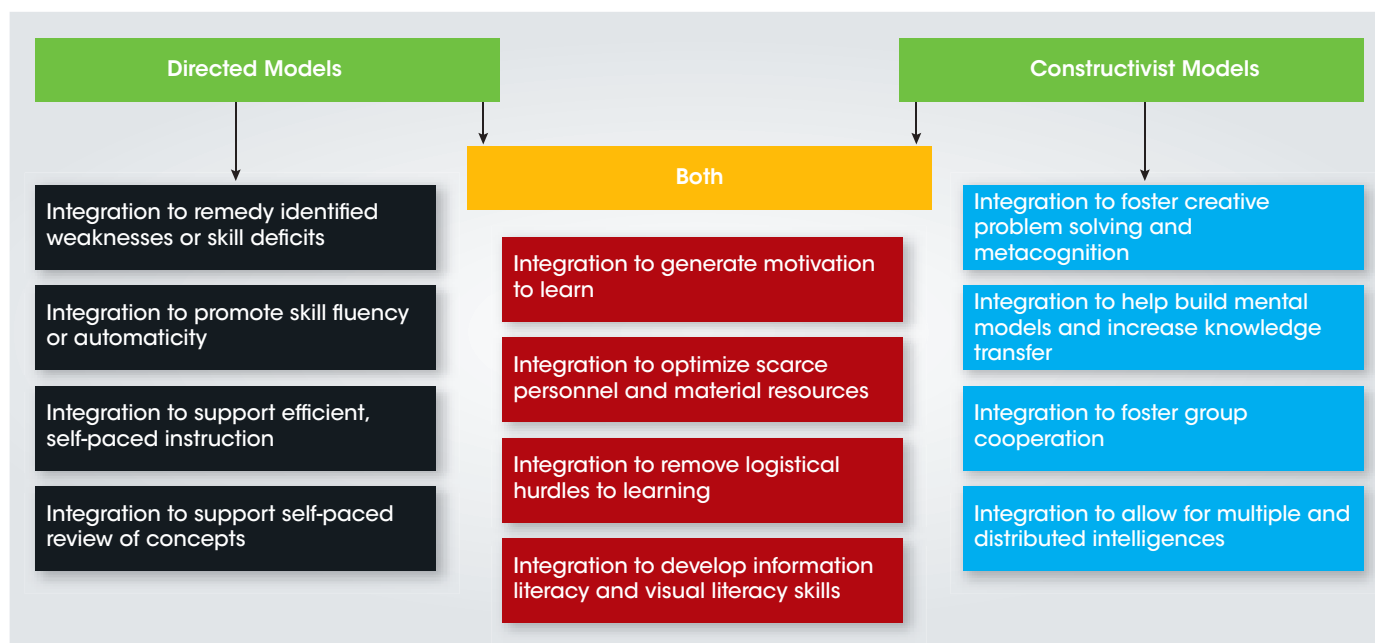
As Figure 7 shows, four technology integration strategies are based primarily on directed models, four are based on constructivist models, and four are strategies that could help address either model. These will be described in more detail in this section.

## Technology Integration Strategies Based on Directed Models

The four integration strategies based on directed methods are all designed to address individual instruction and practice (see Table 3).

**Integration to remedy identified weaknesses or skill deficits.** Constructivists say that students should learn prerequisite skills as they see the need for them in a group or individual project. However, experienced teachers know that even motivated students do not always learn skills as expected. These failures occur for a variety of reasons, many of which are related to learners' internal capabilities, and not all of which are thoroughly understood. When the absence of prerequisite skills presents a barrier to higher level learning or to passing tests, directed instruction usually is the most efficient way of providing these skills. Materials such as drill-and-practice and tutorial software have proven to be valuable resources for providing this kind of individualized instruction. When students have failed to learn required skills, they frequently find technology-based materials more

**FIGURE 7** Technology Integration Strategies for Directed, Constructivist, or Both Models



**Table 3** Technology Integration Strategies Based on Directed Teaching Models

Integration Strategy	Needs/Problems Addressed	Example Activities
To remedy identified weaknesses or skill deficits	<ul style="list-style-type: none"> <li>At-risk students need individual instruction and practice.</li> <li>Students fail parts of high-stakes tests.</li> </ul>	Tutorial or drill-and-practice software is targeted to identified skills.
To promote skill fluency/automaticity	<ul style="list-style-type: none"> <li>Students need to be able to recall and apply lower level skills quickly, automatically.</li> <li>Students need to review for upcoming tests.</li> </ul>	Drill-and-practice or instructional game software lets students practice math facts, vocabulary, or spelling words.
To support efficient, self-paced learning	<ul style="list-style-type: none"> <li>Students are motivated and able to learn on their own.</li> <li>No teacher is available for the content area.</li> </ul>	Use tutorial software or distance learning courses for foreign languages, higher level science or math, or other elective subjects.
To support self-paced review of concepts	<ul style="list-style-type: none"> <li>Students need help studying for test.</li> <li>Students need make-up instruction for missed work.</li> </ul>	Use tutorial, drill-and-practice, or simulation software to cover specific concepts.

motivating and less threatening than teacher-delivered instruction.

#### Integration to promote skill fluency or automaticity.

Some prerequisite skills must be applied quickly and without conscious effort in order to be most useful. Gagné (1982) and Bloom (1986) referred to this automatic recall as **automaticity**. Students need rapid recall and performance of a wide range of skills throughout the curriculum, including simple math facts, grammar and usage rules, and spelling. Some students acquire automaticity through repeated use of the skills in practical situations, while others acquire it more efficiently through isolated practice. Drill-and-practice, instructional games, and, sometimes, simulation courseware can provide practice tailored to individual skill needs and learning pace.

#### Integration to support efficient, self-paced learning.

When students are self-motivated and have the ability to structure their own learning, the most desirable method is often the one that offers the fastest and most efficient path. Sometimes these students are interested in topics not being covered in class or for which there is no instructor available. Directed instruction for these students can frequently be supported by well-designed, self-instructional tutorials and self-paced distance learning workshops and courses.

#### Integration to support self-paced review of concepts.

When students cover a number of topics over time, they usually need a review prior to taking a test to help them remember and consolidate concepts. Sometimes students

are absent when in-class instruction was given or need additional time going over the material to understand and remember it. In these situations, drill-and-practice and tutorial software materials are good ways to provide these kinds of self-paced reviews.

## Technology Integration Strategies Based on Constructivist Models

This section reviews the four integration strategies identified with constructivist methods. The strategies are summarized in Table 4.

#### Integration to foster creative problem solving and metacognition.

Although most people acknowledge the importance of students having a knowledge base of specific skills and information, it is also becoming evident that our world is too complex and technical for students to learn ahead of time everything they may need for the future. Thus, our society is beginning to place a high value on the ability to solve novel problems in creative ways. If students are conscious of the procedures they use to solve problems, they often can more easily improve on their strategies and become more effective, creative problem solvers. Consequently, teachers often try to present students with novel problems to solve and to get them to analyze how they learn to solve them. Resources such as problem-solving courseware and multimedia applications are often considered ideal environments for getting students to think about

**Table 4** Technology Integration Strategies Based on Constructivist Models

Integration Strategy	Needs/Problems Addressed	Example Activities
To foster creative problem solving and metacognition	<ul style="list-style-type: none"> <li>Students need to be able to solve complex, novel problems as they occur.</li> <li>Teachers want to encourage students' self-awareness of their own learning strategies.</li> </ul>	<ul style="list-style-type: none"> <li>Video-based scenarios pose problems, help support student problem solving.</li> <li>Graphic tools illustrate concepts and support student manipulation of variables.</li> <li>Simulations allow exploration of how systems work.</li> </ul>
To help build mental models and increase knowledge transfer	<ul style="list-style-type: none"> <li>Students have trouble understanding complex and/or abstract concepts.</li> <li>Students have trouble seeing where skills apply to real-life problems.</li> </ul>	<ul style="list-style-type: none"> <li>Video-based scenarios pose problems.</li> <li>Students create multimedia products to illustrate and report on their research.</li> <li>Simulations, problem-solving software illustrate and let students explore complex systems.</li> </ul>
To foster group cooperation skills	<ul style="list-style-type: none"> <li>Students need to be able to work with others to solve problems and create products.</li> </ul>	Students collaborate to: <ul style="list-style-type: none"> <li>Do Internet research.</li> <li>Create multimedia/web page products.</li> <li>Compete in instructional games.</li> </ul>
To allow for multiple and distributed intelligences	<ul style="list-style-type: none"> <li>Teachers want to allow students multiple ways to learn and to demonstrate achievement.</li> </ul>	Students have varying roles in group work to create: <ul style="list-style-type: none"> <li>Multimedia products.</li> <li>Web pages.</li> <li>Desktop-published newsletters, brochures.</li> </ul>

how they think and for offering opportunities to challenge their creativity and problem-solving abilities.

**Integration to help build mental models and increase knowledge transfer.** The problem of inert knowledge is believed to arise when students learn skills in isolation from problem applications. When students later encounter problems that require the skills, they do not realize how the skills could be relevant. Problem-solving materials in highly visual formats allow students to build rich mental models of problems to be solved (CTGV, 1991). For example, visual information allows users to easily recognize patterns (CTGV, 1990). Students need not depend on reading skills, which may be deficient, to build these mental models. Thus, supporters hypothesize that teaching skills in these highly visual, problem-solving environments helps ensure that knowledge will transfer to higher order skills. These technology-based methods are especially desirable for teachers who work with students in areas such as mathematics and science, where concepts are abstract and complex and where inert knowledge is frequently a problem.

**Integration to foster group cooperation skills.** One skill area currently identified as an important focus for schools' efforts to restructure curriculum is the ability to work cooperatively in a group to solve problems and develop products



Technology integration strategies support a variety of teaching and learning needs ranging from providing efficient practice in basic skills to constructivist activities such as fostering group cooperation skills. Photo by W. Wiencke.

(Johnson & Johnson, 2004, 2005; Johnson, Johnson, & Holubec, 1992; Kirschner, 2001). Although schools certainly can teach cooperative work without technology resources, a growing body of evidence documents students' appreciation of cooperative work as both more motivating and easier to accomplish when it uses technology.

**Integration to allow for multiple and distributed intelligences.** Integration strategies with group cooperative activities also give teachers a way to allow students of widely varying abilities to make valuable contributions on their own terms. Since each student is seen as an important member of the group in these activities, the activities themselves are viewed as problems for group—rather than individual—solution. This strategy has implications for enhancing students' self-esteem and for increasing their willingness to spend

more time on learning tasks. It also allows students to see that they can help each other accomplish tasks and can learn from each other, as well as from the teacher or from media.

## Enabling Integration Strategies Useful with Either Model

Some integration strategies have a more general support role for instruction and can address the needs of either model. These “enabling” strategies seem to be appearing with increasing frequency in combination with other directed or constructivist strategies described in this chapter, supporting the other strategies and making them more feasible and practical. The four strategies are summarized in Table 5 and the following sections.

**Table 5** Technology Integration Strategies to Support Either Model

Integration Strategy	Needs/Problems Addressed	Example Activities
<b>To generate motivation to learn</b>	<ul style="list-style-type: none"> <li>• Due to past failures, at-risk students need more than usual motivation.</li> <li>• Students need to see the relevance of new concepts and skills to their lives.</li> <li>• Students need to be active, rather than passive, learners.</li> </ul>	<ul style="list-style-type: none"> <li>• Visual and interactive qualities of the Internet and multimedia resources draw and hold students' attention.</li> <li>• Drill-and-practice/tutorial materials give students private environments for learning and practice.</li> <li>• Video-based scenarios, simulations show relevance of science and math skills.</li> <li>• Hands-on production work (e.g., multimedia, web pages) gives students an active role in learning.</li> </ul>
<b>To optimize scarce personnel and material resources</b>	<ul style="list-style-type: none"> <li>• Schools have limited budgets, must save money on consumables.</li> <li>• Teachers are in short supply in some subject areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Simulations allow repeated science experiments at no additional cost.</li> <li>• Distance courses can offer subjects for which schools lack teachers.</li> </ul>
<b>To remove logistical hurdles to learning</b>	<ul style="list-style-type: none"> <li>• Students find repetitive tasks (handwriting, calculations) boring and tedious.</li> <li>• Students lack motor skills to show their designs.</li> <li>• Students cannot travel to places to learn about them.</li> <li>• Some social and physical phenomena occur too slowly, too quickly, or at too great a distance to allow observation.</li> </ul>	<p>Students can use:</p> <ul style="list-style-type: none"> <li>• Word processing to make quick, easy revisions and corrections to written work.</li> <li>• Calculators and spreadsheets to do low-level calculations involved in math/science problem solving.</li> <li>• Computer-assisted design (CAD) and drawing software to try out and change designs.</li> <li>• Virtual tours to see places the students could not go physically.</li> <li>• Simulations to allow study of social systems (e.g., voting) and physical systems (chemical reactions).</li> </ul>
<b>To develop information literacy/visual literacy skills</b>	<p>Students need to learn:</p> <ul style="list-style-type: none"> <li>• Modern methods of communicating information.</li> <li>• How to analyze the quality of visual presentations.</li> </ul>	<p>Students can:</p> <ul style="list-style-type: none"> <li>• Do research reports as multimedia products or web pages.</li> <li>• Become media savvy by using information on the Internet and video.</li> </ul>

**Integration to generate motivation to learn.** Teachers who work with at-risk students say that capturing students' interest and enthusiasm is key to success; frequently, they cite it as their most difficult challenge. Some educators assert that today's entertainment-oriented students are increasingly likely to demand more motivational qualities in their instruction than students in previous generations did. Constructivists argue that instruction must address students' affective needs as well as their cognitive ones, saying that students will learn more if what they are learning is interesting and relevant to their needs. They recommend the highly visual and interactive qualities of Internet and multimedia resources as the basis of these strategies. Proponents of directed methods make similar claims about highly structured, self-instructional learning environments. They say that some students find it very motivating to learn at their own pace in a private environment because they receive immediate feedback on their progress. It seems evident that appropriate integration strategies to address motivation problems depend on the needs of the student; either constructivist or directed integration strategies can be used to increase motivation to learn.

**Integration to optimize scarce resources.** Current resources and numbers of personnel in schools are rarely optimal. Computer-based courseware materials can help make up for the lack of required resources in the school or classroom—from consumable supplies to qualified teachers. For example, drill-and-practice programs can replace worksheets, a good distance program can offer instruction in topics for which local teachers are in short supply, and a simulation can let students repeat experiments without depleting chemical supplies or other materials.

**Integration to remove logistical hurdles to learning.** Some technology tools offer no instructional sequence or tasks but help students complete learning tasks more efficiently. These tools support directed instruction by removing or reducing logistical hurdles to learning. For example, word processing programs do not teach students how to write, but they let students write and rewrite more quickly, without the labor of handwriting. CAD software does not teach students how to design a house, but it allows them to try out designs and features to see what they look like before building models or structures. A calculator lets students do lower level calculations so they can focus on the high-level concepts of math problems. A website might contain only a set of pictures of sea life, but it lets a teacher illustrate concepts about sea creatures more quickly and easily than he or she could with books.

**Integration to develop information literacy and visual literacy skills.** A rationale underlying many of the most popular directed and constructivist integration strategies is the need to give students practice in using modern

methods of communicating information. For example, when students use presentation software instead of cardboard charts to give a report, they gain experience for college classrooms and business offices, where computer-based presentations are the norm. Using technology to communicate visually represents Information Age skills that students will need both for higher education and in the workplace.

## A TECHNOLOGY INTEGRATION PLANNING (TIP) MODEL FOR TEACHERS

This section introduces a model to help teachers—especially those new to technology use—understand how to integrate technology into their teaching. This introduction includes an overview of how the model was developed, a discussion of each of its component steps, and an example of the tasks and product required in each step.

### An Overview of the TIP Model

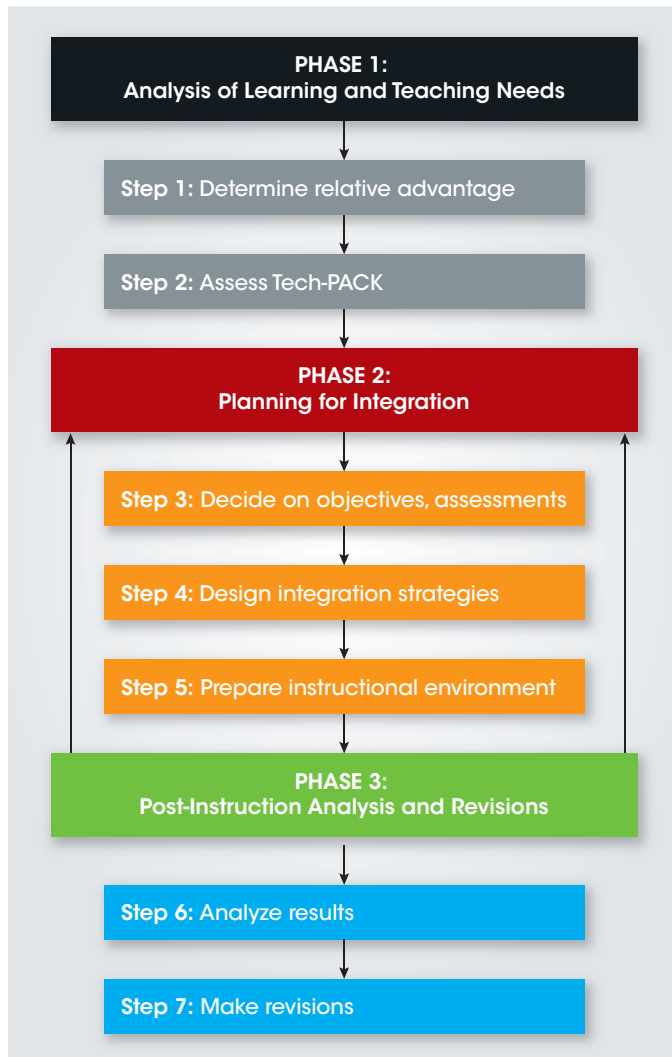
Regardless of the technology integration strategy they use, teachers need a planning approach to ensure their strategy will be successful. The Technology Integration Planning (TIP) Model, shown in Figure 8, is a problem-solving model that is useful when teachers are faced with selecting best strategies and materials, and they decide that they would like to try digital technologies to meet their needs. The TIP Model gives teachers a general approach to identifying and addressing challenges involved in integrating technology into teaching.

Each step in the model's three broad phases helps ensure that technology use will be meaningful, efficient, and successful in meeting needs. Experienced technology-using teachers tend to do these steps intuitively. However, for new teachers or those just beginning to integrate technology, the TIP Model provides a helpful guide on procedures and issues to address. After giving an overview of the model, we will discuss each phase in more depth. A classroom example (the "Online Multicultural Project") of how to implement the tasks is also given in this chapter.

**An Overview of the Phase 1 Focus: Analysis of Learning and Teaching Needs.** When teachers teach a topic for the first time or when the strategies they have used to teach have not been as effective as they would like, they begin with two analysis steps:

- » **Overview of Step 1: Will a technology-based method offer relative advantage?** As teachers look at their current teaching problems and needs, they consider

## FIGURE 8 The Technology Integration Planning Model



technology-based methods that promise good solutions. In his best-selling, research-based book on how and why innovations get adopted, Everett Rogers (2004) said that people resist changing how they do things, even if new ways are better. However, people are more likely to change if they see clearly the benefits of a new method over an old one. He called this seeing a **relative advantage**.

- » **Overview of Step 2: What is my technological pedagogical content knowledge (Tech-PACK)?** Teaching is a complex combination of what teachers know about the content they teach, how they decide to teach that content, and the tools they use to carry out their plans. Historically, teacher education has centered on content knowledge and pedagogy as separate concerns. Shulman (1986) stressed the importance of how these components work together, rather than separately, and

Hughes (2000) extended Shulman's concept by adding technology as another component of knowledge needed by teachers. (See Table 6 for a history of TPACK's development.) Originally called **TPCK** (and later, **TPACK**), or the combination of technological pedagogical content knowledge required to integrate technology most effectively into instruction, this text refers to this combination as "Tech-PACK" to emphasize the critical contribution of technology to teaching. Teachers' metacognitive awareness of Tech-PACK enables them to identify what they must learn more about in order to implement a given technology integration strategy to best effect (Mishra & Koehler, 2006). Figure 9 shows a Venn diagram usually used to illustrate the overlap among the three components of the model. The ideal expertise that teachers aim for is the "zone" at the center of the diagram when all three areas are merged.



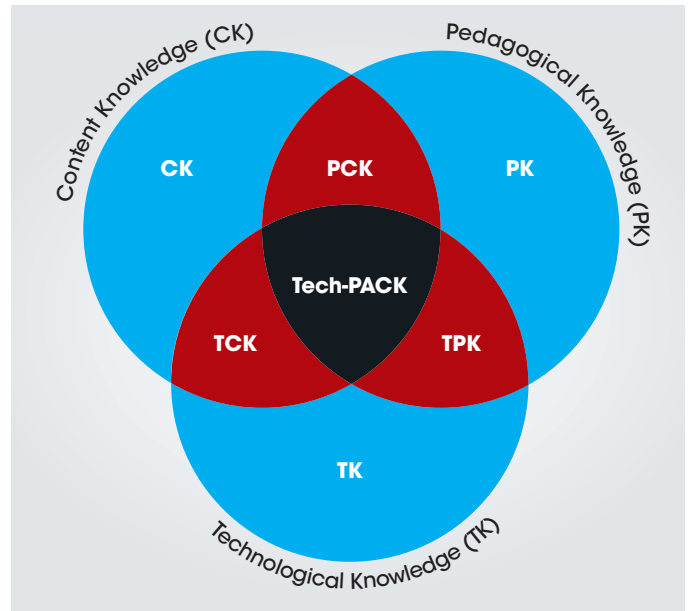
Effective technology integration depends on essential conditions such as adequate funding and up-to-date resources.

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**Table 6 A Brief History of TPACK**

1986	Shulman says pedagogy and content knowledge (PCK) must be considered together
2000	Hughes adds technology to form TPCK (technological pedagogical content knowledge)
2006	Mishra and Koehler articulate the interdependence of content, pedagogy, and technology knowledge
2007	TPCK becomes TPACK as Thompson and Mishra say it better represents the interdependence of the three knowledge domains and represents the “Total PACKage” of teacher knowledge required for technology integration
2012	TPACK becomes Tech-PACK as Roblyer and Doering emphasize the critical contribution of technology to teaching

**FIGURE 9 Technological Pedagogical Content Knowledge Model (Tech-PACK)**

**An Overview of the Phase 2 Focus: Planning for Integration.** In this phase, teachers do three activities that result in plans and products to carry out instruction, assess students, and create an environment that will support technology integration:

- » **Overview of Step 3: How will I know students have learned?** Teachers decide on the skills they want students to learn from the technology-integrated lesson(s) and design ways to assess how well students have learned and how effectively the activity has been carried out.
- » **Overview of Step 4: What teaching strategies and activities will work best?** Teachers decide on instructional strategies and how to carry them out. When teachers create an instructional design for technology integration, they consider the characteristics of their topic and the needs of their students and decide on an instructional course of action that addresses both within the constraints of their classroom environment.
- » **Overview of Step 5: Are essential conditions in place to support technology integration?** Teachers organize the teaching environment so that technology plans can be carried out effectively. Since research on effective technology uses shows that teachers can integrate technology successfully only if they have adequate hardware, software, and technical support available to them, ISTE (2008) listed a set of essential conditions for unleashing the potential power of

technology tools and methods. For each technology integration strategy, the teacher determines that conditions are in place to support the desired integration strategies. An important concern here is providing essential conditions needed for all students to learn, including those with special needs. For more information about how to do this, see the Adapting for Special Needs feature.

**An Overview of the Phase 3 Focus: Post-Instruction Analysis and Revisions.** Planning does not stop after the lesson has been implemented. Instead, teachers complete two further steps to prepare for the next time they use the integration strategy:

- » **Overview of Step 6: What worked well? What could be improved?** Teachers review outcome data and information on technology-integrated methods and determine what should be changed to make them work better next time. In addition to collecting formal data on instructional and other outcomes, teachers sometimes interview students and observers to ask what they think could be improved. Some teachers keep daily notes or logs on implementation problems and issues. As they review all the information, teachers can use the Technology Impact Checklist (located in MyEducationLab) to help them reflect on whether the problems they identified in Phases 1 and 2 have indeed been addressed successfully.



# ADAPTING FOR SPECIAL NEEDS

## Universal Design for Learning

Universal Design for Learning (UDL) is a framework that has important implications for technology use in the classroom. UDL means, among other things, proactively valuing academic diversity in ways that enhance access, engagement, and learning outcomes. One of the mantras of UDL is that instructional design that is deliberately created for individuals with disabilities often provides significant benefits to all students. The essence of UDL involves three components:

- » Multiple means of representation to give learners various ways of acquiring information and knowledge;
- » Multiple means of expression to provide learners with alternatives for demonstrating what they know; and
- » Multiple means of engagement to tap into learners' interests, to challenge them appropriately, and to motivate them to learn.

Traditionally, when educators fail to recognize that 25 to 50% of the students in their classroom may not read at grade level, they distribute textbooks that have a readability level *above* grade level. However, using the principle of multiple means of representation, an educator plans instruction to provide access to digital text so that students can manipulate the physical nature of the text (e.g., change the font size, color contrasts), as well as alter the cognitive difficulty by using tools such as text-to-speech (e.g., [www.vozme.com](http://www.vozme.com)) or auto-summarization (e.g., [www.textcompactor.com](http://www.textcompactor.com)).

Learn more about universal design for learning in order to understand its applications for your own classroom by visiting:

- » Teaching Every Student in the Digital Age: <http://www.cast.org/teachingeverystudent/ideas/tes>
- » Teaching Every Student Blog: <http://teachingeverystudent.blogspot.com>

*Contributed by Dave Edyburn*

- » **Overview of Step 7: Revisions.** Based on findings from Step 6, teachers make any changes that are needed to achieve even better results in terms of student outcomes.

Now we turn to a more detailed look at each of these focuses. The following sections tell how to implement each step in the model.

### Phase 1: Analysis of Learning and Teaching Needs

This phase in integrating technology requires analyzing classroom problems and how technology-based strategies could address them. This section will give a detailed description of the Phase 1 analysis steps and an explanation of why each is necessary. Also see Phase 1 of the Technology Integration Example, which shows how to implement this phase of the model.

**Step 1: Determining relative advantage.** Every teacher has topics—and sometimes whole subject areas—that he or she finds especially challenging to teach. Some concepts are so abstract or foreign to students that they struggle to understand them; some students find some topics so boring, tedious, or irrelevant that they have trouble attending to them. Some learning requires time-consuming tasks that students

resist doing. Good teachers spend a lot of time trying to meet these challenges by making concepts more engaging or easier to grasp, or making tasks more efficient to accomplish.

Technology-based strategies offer many unique benefits to teachers as they look for instructional solutions to these problems. Time and effort are required to plan and carry out technology-based methods, however, and sometimes additional expense is involved as well. Teachers have to consider the benefits of such methods compared to their current methods and decide if the benefits are worth the additional effort and cost.

As mentioned earlier, Everett Rogers (2004) refers to this decision as seeing the relative advantage of using a new method. Table 7 lists several kinds of learning problems and technology solutions with potential for high relative advantage to teachers. However, these lists are really just guidelines. Being able to recognize specific instances of these problems in a classroom context and knowing how to match them with an appropriate technology solution require knowledge of classroom problems, practice in addressing them, and an in-depth knowledge of the characteristics of each technology. Deciding whether to integrate technology requires answering the following two questions about technology's relative advantage in a given situation:

- » **What is the problem?** To make sure a technology application is a good solution, begin with a clear

**Table 7** Technology Solutions with Potential for High Relative Advantage

Learning Problem	Technology Solutions	Relative Advantage
Concepts are new, foreign (e.g., mathematics, physics principles).	Graphic tools, simulations, video-based problem scenarios	Visual examples clarify concepts and applications.
Concepts are abstract, complex (e.g., physics principles, biology systems).	Math tools (Geometer's <i>SketchPad</i> ), simulations, problem-solving software, spreadsheet exercises, graphing calculators	Graphics displays make abstract concepts more concrete; students can manipulate systems to see how they work.
Time-consuming manual skills (e.g., handwriting, calculations, data collection) interfere with learning high-level skills.	Tool software (e.g., word processing, spreadsheets) and probeware	Takes low-level labor out of high-level tasks; students can focus on learning high-level concepts and skills.
Students find practice boring (e.g., basic math skills, spelling, vocabulary, test preparation).	Drill-and-practice software, instructional games	Attention-getting displays, immediate feedback, and interaction combine to create motivating practice.
Students cannot see relevance of concepts to their lives (e.g., history, social studies).	Simulations, Internet activities, video-based problem scenarios	Visual, interactive activities help teachers demonstrate relevance.
Skills are "inert," i.e., students can do them but do not see where they apply (e.g., mathematics, physics).	Simulations, problem-solving software, video-based problem scenarios, student development of web pages, multimedia products	Project-based learning using these tools establishes clear links between skills and real-world problems.
Students dislike preparing research reports, presentations.	Student development of desktop-published and web page/multimedia products	Students like products that look polished, professional.
Students need skills in working collaboratively, opportunities to demonstrate learning in alternative ways.	Student development of desktop-published and web page/multimedia products	Provides format in which group work makes sense; students can work together "virtually"; students make different contributions to one product based on their strengths.
Students need technological competence in preparation for the workplace.	All software and productivity tools; all communications, presentation, and multimedia software	Illustrates and provides practice in skills and tools students will need in work situations.
Teachers have limited time for correcting students' individual practice items.	Drill-and-practice software, handheld computers with assessment software	Feedback to students is immediate; frees teachers for work with students.
No teachers available for advanced courses.	Self-instructional multimedia, distance courses	Provides structured, self-paced learning environments.
Students need individual reviews of missed work.	Tutorial or multimedia software	Provides structured, self-paced environments for individual review of missed concepts.
Schools have insufficient consumable materials (e.g., science labs, workbooks).	Simulations, ebooks	Materials are reusable; saves money on purchasing new copies.
Students need quick access to information and people not locally available.	Internet and email projects; multimedia encyclopedias and atlases	Information is faster to access; people are easier, less expensive to contact.

statement of the teaching and learning problem. This is sometimes difficult to do. It is a natural human tendency to jump to a quick solution rather than to recognize the real problem. Also, everyone may not see a problem the same way. Use the following guidelines when answering the question, “What is the problem?”

- Do not focus on nonuse of technologies—Remember that knowing how to use a technology appropriately is part of a solution, not in itself a problem to solve. Therefore, avoid problem statements like “Students do not know how to use spreadsheets efficiently,” or “Teachers are not having their students use the Internet.” Not having the skills to use a technology (e.g., a spreadsheet or the Internet) is an instructional problem, but not the kind of teaching/learning problem to be considered here. It is sometimes true that teachers are given a technology and told to implement it. In these situations, they must decide if there is a real teaching or learning problem the new resource can help meet. If teachers have a technology available and choose not to use it, however, it may mean they can see no relative advantage to using it; nonuse of a technology is not in itself a problem to address with the TIP Model.
  - Look for evidence—Look for observable indications that there really is a problem. Examples of evidence include the following: students consistently achieve lower grades in a skill area, a formal or informal survey shows that teachers have trouble getting students to attend to learning tasks, or teachers observe that students are refusing to turn in required assignments in a certain area.
- » **Do technology-based methods offer a solution with sufficient relative advantage?** Analyze the benefits of the technology-based method in light of the effort and cost to implement it, and then make a final decision. First, use the following guidelines to help determine whether your methods should be primarily directed or constructivist:
- Use directed strategies when students need an efficient way to learn specific skills that must be assessed with traditional tests.
  - Use constructivist strategies when students need to develop global skills and insights over time (e.g., cooperative group skills, approaches to solving novel problems, mental models of highly complex topics)

## TECHNOLOGY INTEGRATION EXAMPLE 1

### PHASE 1: ANALYZING LEARNING AND TEACHING NEEDS

Mia wanted to include more meaningful multicultural activities in the social studies curriculum. She and the other social studies teachers in her school focused primarily on studying various holidays and foods from other cultures. They sponsored an annual International Foods smorgasbord event that was very popular with the students, but she doubted it taught them much about the richness of other cultures or why they should respect and appreciate cultures different from their own. She sometimes overheard her students making disparaging comments about people of other nationalities. Mia felt a better approach to multicultural education might help, but she wasn't sure she had enough background knowledge to be able to develop a more meaningful project.

Mia concluded that she could follow a model she heard about while attending a workshop the previous summer. At the workshop, teachers at another school district described an online project with partner schools in countries around the world. One teacher told about her partners in Israel and Spain. She said students exchanged information with designated partners and answered assigned questions to research each other's backgrounds and locales. Then they worked in groups on travel brochures or booklets to email to each other. They even took digital photos of themselves to send. It sounded like a great way for kids to learn about other cultures in a meaningful way while also learning some geography and civics. The teachers in the workshop remarked that it was difficult to demean people who look and talk differently from you when you've worked with them and gotten to know them. Mia was so impressed with the online project they described that she decided to try it out in her own classroom, even though she didn't know anything about digital cameras or the online resources used in the project. She knew some information about some of the cultures they would be studying, but not all she would need to know. However, she felt she could structure a good curriculum around these activities, once she knew about what was needed.

#### PHASE 1 ANALYSIS QUESTIONS

1. What is the problem Mia wants to address?
2. What evidence does she have that there is a problem?
3. What would be the relative advantage of the method she is proposing?
4. In what ways does she hope this method will be better than previous ones?
5. What deficits does she have in technology, content, and pedagogical knowledge?
6. How could she go about addressing these needs to improve her Tech-PACK?

and when learning may be assessed with alternative measures, such as portfolios or group products.

Then examine the needs and integration strategies described in Tables 3 through 5, and determine which one(s) apply for the situation. Select one that seems to be a good match to the problem and situation you have identified in your own classroom. Use the following guidelines to answer the question, “Is technology a good solution?”

- » **Estimate the impact**—Consider the benefits others have gained from using the technology as a solution. Is it likely you will realize similar benefits?
- » **Consider the required effort and expense**—How much time and work will it take to implement the technology solution? Is it likely to be worth it?

**Step 2: Tech-PACK assessment.** Next, teachers self-assess their ability to carry out the integration strategy they have chosen. They analyze the intersection of the three knowledge domains—content, pedagogy, and technology—by reflecting on the following questions:

- » **What is my content knowledge (CK)?** Information in some content areas (especially in sciences and social studies) changes frequently, as do state content standards. As teachers think about topics they are about to teach (or teach again), they reflect on whether they know the latest, most up-to-date information about the content and the standards their students must meet. If the topic is assessed through a state-mandated exam, teachers can review study guides and other prepared materials to make sure they know content at the required depth they will need in order to develop an effective lesson. If they find they do not know the content information as well as they need to, they must go to the required authority (tests, etc.) and acquire the new content knowledge they need.
- » **What is my knowledge of pedagogy (PK)?** Every content and skill area has a body of knowledge about how best to teach it. Each field updates its pedagogical knowledge over time by reporting new research and experiences. Some of this accumulated knowledge on best pedagogical practices can be found in teacher manuals that accompany textbooks or other instructional materials, but more recent information may be available in journals or teacher magazines. As teachers consider these new methods, they also reflect on whether they know enough about them to implement them in their classroom. If they feel deficient in this area, they may need to synthesize the newly available

best practices and prepare more planning notes than they normally would on how best to engage students, show examples, illustrate concepts, provide practice, and so on.

- » **What is my knowledge of technology (TK)?** New technologies, especially those that are computer-based and online, tend to emerge frequently, making it challenging for teachers to keep up with skills and techniques they need to know to take advantage of them. Many of these technologies were not introduced in teachers’ preparation programs or have come into use since teachers left their preparation programs. In addition, even “older” technologies that teachers already learned tend to change on a regular basis. For example, the programs in the most recent version of the *Microsoft Office* suite look and act much differently from those in the previous version. As teachers consider various technology integration strategies, they may need to read up on new or updated technology products and consider what they will need to learn about them to employ them efficiently and help students learn how to use them. Some of this new information is available in product manuals, but some requires teachers to obtain professional development or assistance from others teachers who have learned the technologies.

## Phase 2: Planning for Integration

This phase in integrating technology requires making decisions about outcomes and how they will be assessed, and about how to arrange and carry out integration strategies. This section will give a detailed description of Phase 2 steps and an explanation of why each is necessary. Also see Phase 2 of the Technology Integration Example , which shows how to implement this phase of the model.

**Step 3: Decide on objectives and assessments.** Writing objectives is a good way of setting clear expectations for what technology-based methods will accomplish. Usually, teachers expect a new method will improve student behaviors—for example, that it will result in better achievement, more on-task behaviors, or improved attitudes. Sometimes, however, changes in teacher behaviors are important—for example, saving time on a task. In either case, objectives should focus on outcomes that are observable (e.g., demonstrating, writing, completing), rather than on internal results that cannot be seen or measured (e.g., being aware, knowing, understanding, or appreciating).

After stating objectives, teachers create ways to assess how well outcomes have been accomplished. Sometimes,

## TECHNOLOGY INTEGRATION EXAMPLE 2

### PHASE 2: PLANNING FOR INTEGRATION

Mia reflected on the problems she saw with her current methods of addressing multicultural education and what she wanted her students to learn about other cultures that they didn't seem to be learning now. She decided on the following three outcomes: better attitudes toward people of other cultures, increased learning about similarities and differences among cultures, and knowledge of facts and concepts about the geography and government of the other country they would study. So that she could measure the success of her project later, she created objectives and instruments to measure the outcomes:

- » Attitudes toward cultures—At least 75% of students will demonstrate an improved attitude toward the culture being studied with a higher score on the post-unit attitude measure than on the pre-unit measure. Instrument: She knew a good way to measure attitudes was with a semantic differential. Before and after the project, students would answer the question: "How do you feel about people from \_\_\_\_\_?" by marking a line between sets of adjectives to indicate how they feel.
- » Knowledge of cultures—Each student group will score at least 90% on a rubric evaluating the brochure or booklet that reflects knowledge of the cultural characteristics (both unique and common to our own) about the people being studied. Instrument: After listing characteristics she wanted to see reflected in the products, she found a rubric to assess them. She decided they should get at least 15 of the 20 possible points on this rubric.
- » Factual knowledge—Each student will score at least 80% on a short-answer test on the government and geography of the country being studied.

#### PHASE 2 ANALYSIS QUESTIONS (SET 1)

1. How do you think Mia should use the product rubric to assign grades?
2. What kinds of questions could Mia include in a survey to measure how much students liked this way of learning?

Mia knew that her students would not achieve the insights she had in mind through a strategy of telling them information and testing them on it. They would need to draw their own conclusions by working and communicating with people from other cultures. However, she felt she could use a directed approach to teach them the Internet and email skills they would need to carry out project activities. The project website had good suggestions on how to set up groups of four with designated tasks for each group member. It also suggested the following sequence of activities for introducing and carrying out the project:

Step 1: Sign up on the project website; obtain partner school assignments.

Step 2: Teachers in partner schools make contact and set a timeline.

Step 3: Teachers organize classroom resources for work on project.

Step 4: Introduce the project to students: Display project information from the project website and discuss previous products done by other sites.

Step 5: Assign students to groups; discuss task assignments with all members.

Step 6: Determine students' email and Internet skills; begin teaching these skills.

Step 7: Students do initial email contacts/chats and introduce themselves to each other.

Step 8: Teacher works with groups to identify information for final product.

Step 9: Students do Internet searches to locate required information; take digital photos and scan required images; exchange information with partner sites.

Step 10: Students do production work; exchange final products with partners.

Step 11: Do debriefing and assessments of student work.

#### PHASE 2 ANALYSIS QUESTIONS (SET 2)

1. Is Mia's approach primarily directed or constructivist?
2. Why did she decide to take this approach?
3. At which point should Mia do the pre-assessments to measure students' skills and attitudes prior to the project?
4. How should Mia determine students' levels of required Internet and email skills?

As soon as Mia knew that her students would be able to participate in the Internet project, she began to get organized. First, she examined the timeline of project activities so she would know when her students needed to use computers. She made sure to build in enough time to demonstrate the project site and to get students used to using the browser and search engine. Then she began the following planning and preparation activities:

- » Handouts for students—To make sure groups knew the tasks each member should do, Mia created handouts specifying timelines and what should be accomplished at each stage of the project. She also made a checklist of information students were to collect and made copies so that students could check off what they had done as they went. She wanted to make sure everyone knew how she would grade their work, so she made copies of the assessments (the rubric and a description of the country information test), handed them out, and discussed them with the students.

*Continued*

» Computer schedule—Mia had a classroom workstation consisting of five networked computers, each with an Internet connection, so she set up a schedule for small groups to use the computers. She knew that some students would need to scan pictures, download image files from the digital camera, and process those files for sending to the partner schools, so she scheduled some additional time in the computer lab for this work. She thought that students could do other work in the library/media center after school if they needed still more time.

**PHASE 2 ANALYSIS QUESTIONS (SET 3)**

1. If Mia wanted to do a demonstration and display of the project website to the whole class at once, what resource(s) would she have to arrange to do this?
2. Mia was concerned about students revealing too much personal information about themselves to people in their partner schools. What guidelines should she give them about information exchanges to protect their privacy and security?
3. If the network or Internet access were interrupted for a day, what could Mia have the students do to make good use of their time during the delay?

# Free open source **OPTIONS** for Assessment Tools for Teachers

**ASSESSMENT OPTIONS**

**FREE SOURCES**

Online survey sites (most have a free, limited-feature option, as well as a for-a-fee option)

Advanced Survey: <http://www.advancedsurvey.com/surveys>  
 Survey Monkey: <http://www.surveymonkey.com>  
 Zoomerang: <http://www.zoomerang.com>  
 SurveyMethods: <http://www.surveymethods.com>

Rubric makers and free prepared rubrics

Kathy Schrock's assessment and rubric sites:  
<http://school.discoveryeducation.com/schrockguide/assess.html>

Test-makers and quiz-makers

Quiz Generator: <http://www.quizgenerator.org>  
 Content Generator: <http://www.contentgenerator.net/multiplechoice> to practice creating documents that you will use in the classroom  
 Easton's list of quiz-maker sites and other free resources:  
<http://eleaston.com/quizzes.html>

they can use existing tests and rubrics. In other cases, they have to create instruments or methods to measure the behaviors. (See the Open Source feature for some free tools to support assessment.)

Here are a few example outcomes, objectives (which are used to state outcomes in a measurable form), and assessment methods matched to the outcomes:

» **Higher achievement outcome**—Overall average performance on an end-of-chapter test will improve by 20%. (Assess achievement with a test.)

» **Cooperative work outcome**—All students will score at least 15 out of 20 on the cooperative group skill rubric. (Use an existing rubric to grade skills.)

» **Attitude outcome**—Students will indicate satisfaction with the simulation lesson by an overall average score of 20 out of 25 points. (Create an attitude survey to assess satisfaction.)

» **Improved motivation**—Teachers will observe better on-task behavior in at least 75% of the students. (Create and use an observation sheet.)

This phase in integrating technology requires answering two questions about outcomes and assessment strategies:

» **Question 1: What outcomes do I expect from using the new methods?** Think about problems you are trying to solve and what would be acceptable indications that the technology solution has succeeded in resolving them. Use the following guidelines:

- *Focus on results, not processes*—Think about the end results you want to achieve, rather than the processes to help you get there. Avoid statements, like “Students will learn cooperative group skills,” that focus on a process students use to achieve the outcome (improved cooperative group skills). Instead, state what you want students to be able to do as a result of having participated in the multimedia project—for example, “Ninety percent of students will score 4 out of 5 on a cooperative group skills rubric.”
- *Make statements observable and measurable*—Avoid vague statements, like “Students will understand how to work cooperatively,” that cannot be measured.

» **Question 2: What are the best ways of assessing these outcomes?** The choice of assessment method depends on the nature of the outcome. Note the following guidelines:

- *Use written tests to assess skill achievement outcomes*—Written cognitive tests (e.g., short answer, multiple choice, true/false, matching) and essay exams remain the most common classroom assessment strategy for many formal knowledge skills.
- *Use evaluation criteria checklists to assess complex tasks or products*—When students must create complex products, such as multimedia presentations, reports, or web pages, teachers may give students a set of criteria that specify the requirements each product must meet. Points are awarded for meeting each criterion.
- *Use rubrics to assess complex tasks or products*—Rubrics fulfill the same role as evaluation criteria checklists and are sometimes used in addition to them. Their added value is giving students descriptions of various levels of quality. Teachers usually associate a letter grade with each level of quality (Level 5 = A, Level 4 = B, etc.).
- *Use Likert scale-type surveys or semantic differentials to assess attitude outcomes*—When the desired outcome is improved attitudes, teachers design a

survey in **Likert scale** format or with a **semantic differential**. The teacher sums the item scores to obtain a measure of student perceptions. A **Likert scale** is a series of statements that students use to indicate their degree of agreement or disagreement. For example:

I like writing more when I use word processing.  
(Circle one of the following numbers.)

Strongly agree	Agree	No opinion	Disagree	Strongly disagree
1	2	3	4	5

In a **semantic differential**, students respond to a question by checking a line between each of several sets of bipolar adjectives to indicate their level of feeling about the topic of the question. For example:

“How do you feel about math?” Check the line closest to the adjective that describes your feeling.

Warm \_\_\_\_\_ Cold?

Happy \_\_\_\_\_ Sad?

Strong \_\_\_\_\_ Weak?

- » Use observation instruments to measure frequency of behaviors—For example, if teachers wanted to see an increase in students’ use of scientific language, they could create a chart to keep track of this use on a daily basis so they could track baseline performance and improvement over time.

**Step 4: Design integration strategies.** Teachers make many design decisions as they integrate technologies into teaching, including single-subject vs. interdisciplinary approach, grouping strategies, and sequence of learning activities. What usually drives these design decisions is whether the learning environment will be primarily directed (a teacher or expert source presents information for students to absorb) or primarily inquiry based or constructivist (students do activities to generate their own learning). In light of this decision, which you made in Step 1, consider each of the following implementation decisions:

- » **Question 1: What kind of content approach is needed?** Should the approach be single subject or interdisciplinary? Sometimes school or district requirements dictate this decision, and sometimes teachers combine subjects into a single unit of instruction as a way to cover concepts and topics they may not otherwise have time to teach. Most often, however, interdisciplinary approaches are used to model how real-life activities



require the use of a combination of skills from several content areas.

» **Question 2: What grouping approach should I use?** Should the students work as individuals, in pairs, in small groups, or as a whole class? This decision is made in light of how many computers or software copies are available, as well as the following guidelines:

- *Whole class:* For demonstrations or to guide whole-class discussion prior to student work
- *Individual:* When students have to demonstrate individual mastery of skills at the end of the lesson or project
- *Pairs:* For peer tutoring; higher ability students work with those of lesser ability
- *Small group:* To model real-world work skills by giving students experience in cooperative group work

» **Question 3: How can I prepare students adequately to use technologies?** When designing a sequence of activities that incorporates technology tools, be sure to leave enough time for demonstrating the tools to students and allowing them to become comfortable using them before they do a graded product.

**Step 5: Prepare the instructional environment.** If teachers could obtain all of the teaching resources they needed whenever they wanted them, they would make all the planning decisions described here *after* they had decided on the best instructional strategies in Step 1. In practice, however, teachers make many Step 1 and Step 5 decisions at the same time, since most usually decide how they will teach something in light of what is available for teaching it. Effective technology use means making sure that the instructional environment meets all of the following essential conditions required for successful technology integration:

- » **Adequate hardware, software, and media**—Enough computers are available, and there are sufficient legal copies of instructional resources.
- » **Time to use resources**—Hardware and enough legal copies of software have been obtained or scheduled for the time needed.
- » **Special needs of students**—Provisions have been made for access by students with disabilities and for all students' privacy and safety.
- » **Planning for technology use**—Teachers are familiar enough with the hardware and software to use it efficiently and do necessary troubleshooting; they have

allowed time for testing and backup of files; they have a backup plan in the event technology resources fail to work as planned.

This step requires answering three questions about preparing an instructional environment that will support technology integration:

» **Question 1: What equipment, software, media, and materials will I need to carry out the instructional strategies?** As you create ways to stretch scarce resources, be sure that your strategies are ethical and in keeping with the reasons you chose a technology-based solution in the first place. Some guidelines:

- *Computers*—If there are not enough computers available to support the individual format you wanted, consider organizing the integration plan around student pairs or small groups. Also consider having computer and noncomputer learning stations that individuals or groups cycle through, completing various activities at each one. However, if students must master skills on an individual basis, consider scheduling time in a computer lab when all students in the class can use resources at once.
- *Copies of software and media*—Unless a software or media package specifically allows it, making copies of published software or media is illegal, even if copies are used on a temporary basis. Inquire about education-priced lab packs and site licenses.
- *Access to peripherals*—In addition to computers, remember to plan for adequate access to printers, printer paper, and any other needed peripherals (e.g., probes, handhelds).
- *Handouts and other materials*—Prepare and copy (or post) necessary support materials. Unless learning to use the software without guidance is a goal of the project, consider creating summary sheets to remind students how to do basic operations.

» **Question 2: How should resources be arranged to support instruction and learning?** Guidelines here include:

- *Access by students with disabilities*—For students with visual or hearing deficits, consider software or adaptive devices created especially to address these disabilities.
- *Privacy and safety issues*—School students should never use the Internet (including social networking

sites) without adult supervision and should never participate in unplanned chat sessions. If possible, firewall software should be used to prevent accidental access to inappropriate sites.

» **Question 3: What planning is required to make sure technology resources work well?** Guidelines here include:

- *Troubleshooting*—Computers, like all machines, occasionally break down. Learn simple diagnostic procedures so you can correct some problems without assistance.
- *Test runs and backup plans*—Leave sufficient time to learn and practice using resources before students use them, but also try out the resources again just before class begins. Have a backup plan in case something goes wrong at the last minute.

### Phase 3: Post-Instruction Analysis and Revisions

This section will give a detailed description of Phase 3 steps and an explanation of why each is necessary. Also see Phase 3 of the Technology Integration Example, which shows how to implement this phase of the model.

As teachers complete a technology-based project with students, they begin reviewing evidence on how successful the strategies and plans were in solving the problems they identified. They use this evidence to decide what should be changed with respect to objectives, strategies, and implementation tasks to ensure even more success next time.

**Step 6. Analyze results.** To do a post-instruction analysis, teachers look at the following issues:

- » **Were the objectives achieved?** This is the primary criterion of success for the activity. Teachers review achievement, attitude, and observation data they have collected and decide if the technology-based method solved the problem(s) they had in mind. These data help them determine what should be changed to make the activity work better.
- » **What do students say?** Some of the best suggestions on needed improvements come from students. Informal discussions with them yield a unique “consumer” focus on the activity.
- » **Could improving instructional strategies improve results?** Technologies in themselves do not usually

## TECHNOLOGY INTEGRATION EXAMPLE 3

### PHASE 3: EVALUATE AND REVISE INTEGRATION STRATEGIES

Mia was generally pleased with the results of the multicultural project. According to the semantic differential, most students showed a major improvement in how they perceived people from the country they were studying. Students she had spoken with were very enthusiastic about their chats and email exchanges. Some group brochures and booklets were more polished than others, but they all showed good insights into the similarities and differences between cultures, and every group had met the rubric criteria on content. The web searches they had done seemed to have helped a lot. One thing that became clear was that production work on their published products was very time consuming; in the future the schedule would have to be changed to allow more time. Mia also realized she had to stress that the deadlines are firm. Students would search for and take digital photos forever if she let them, and that put them behind on doing their products and left little time to discuss their findings on comparisons of cultures. Results varied on the short-answer test on the government and geography of the country being studied. Only about half the students met the 80% criterion. Mia realized she would have to schedule a review of this information before the test. She decided to make this a final group task after the production work was done.

#### PHASE 3 ANALYSIS QUESTIONS

1. Although all of Mia’s groups did well on context overall, rubric scores revealed that most groups scored lower in one area: spelling, grammar, and punctuation in the products. What steps could Mia add to the production work checklist that might improve this outcome next time?
2. If Mia found that only five of the seven groups in the class were doing well on their final products, what might she do to find out more about why this was happening?
3. One teacher who observed the project told Mia that it might be good to have the school district media/materials production office do the final work on the products for the students. Does this seem like a good idea? Why or why not?

improve results significantly; it is the way teachers use them that is critical. Look at the design of both the technology use and the learning activities surrounding it.

- » **Could improving the environment improve results?** Sometimes a small change, such as better scheduling or access to a printer, can make a big difference in a project's success.
- » **Have I integrated technology well?** Use the Technology Impact Checklist (see MyEducationLab) to determine if the activity has been “worth it.”

This phase in integrating technology requires answering two summary questions about evaluating and revising technology integration strategies:

- » **How well has the technology integration strategy worked?** Review the following collected data to answer this question.
  - *Achievement data*—If the problem was low student achievement, do data show students are achieving better than they were before? If the goal was improved motivation or attitudes, are students achieving at least as well as they did before? Is higher achievement consistent across the class, or did some students seem to profit more than others?
  - *Attitude data*—If the original problem was low motivation or students refusing to do required work, are there indications this behavior has improved? Has it improved for everyone or just for certain students?
  - *Students' comments*—Be sure to ask both lower achieving and higher achieving students for their opinions. Even if achievement and motivation seem to have improved, what do students say about the activity? Do they want to do similar activities again?
- » **What could be improved to make the technology integration strategy work better?** The first time you do a technology-based activity, you can expect it will take longer and you will encounter more errors than in subsequent uses. The following areas are most often cited as needing improvement:
  - *Scheduling*—If students request any change, it is usually for more time. This may or may not be feasible, but you can review the schedule to determine if additional time can be built in for learning software and/or for production work.
  - *Technical skills*—It usually takes longer than expected for students to learn the technology tools. How can this learning be expedited or supported better?

- *Efficiency*—From the teacher's point of view, the complaint is usually that the activity took longer than expected to plan and carry out. Review the schedule to see if there is any way the activity can be expedited.

**Step 7. Make revisions.** Based on the results from Step 6, teachers make adjustments to materials, logistics, and/or strategies. Revision activities are on a continuum ranging from small changes in how materials are used all the way to going back to Step 1 and re-analyzing the problem–solution match. Evidence in the form of student outcomes must drive these decisions.

As a planning tool, the TIP model makes the questions concrete that teachers need to think through when designing instruction that uses technology. Used together, Tech-PACK and TIP are the theory and practice tools that make technology integration purposeful, effective, and meaningful for teachers and students alike.

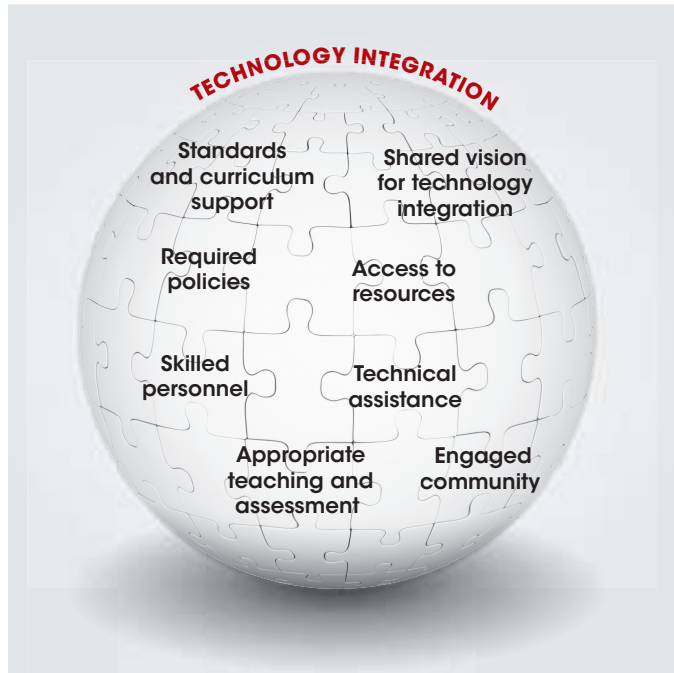
## WHEN TECHNOLOGY WORKS BEST: ESSENTIAL CONDITIONS FOR TECHNOLOGY INTEGRATION

When ISTE established National Education Technology Standards (NETS) for teachers, students, and administrators, they also described conditions necessary for teachers to exploit the potential power of technology. As ISTE leaders introduced NETS in forums around the country, teachers spoke of barriers they had encountered when they attempted to implement technology in their schools or classrooms. The essential conditions were distilled from these comments. These conditions are summarized in ISTE's *NETS for Teachers* (2008) book, as well as online at <http://www.iste.org>. Once teachers complete an effective preparation program and take positions in schools, their ability to use technology to good advantage is determined in large part by whether the school district and/or school have provided the conditions described here. A summary of the essential conditions for effective technology integration is shown in Figure 10.

### Essential Condition: A Shared Vision for Technology Integration

Teachers need system-wide support to implement technology. This means that the school, district, local community,

## FIGURE 10 Essential Conditions for Effective Technology Integration



The TIP Model helps teachers reflect on technology-based strategies that offer relative advantage in the search for instructional solutions to current learning problems.

Photo by W. Wiencke

and state share with teachers a commitment to using technology to support teaching and learning. Usually, this commitment is documented in the form of a statewide and/or district-wide plan created as a cooperative effort of teachers, administrators, and community business partners. The National Center for Technology Planning (<http://www.nctp.com>) offers guidelines for planning strategies and examples of school and district plans. To ensure that teachers and administrators have a shared vision for how technology should be supported, all technology plans should reflect the qualities discussed next.

**Coordinate school and district planning, and involve teachers and other personnel at all levels.** Plans at the school and district levels should be coordinated with each other. It is helpful if each school has a technology liaison/coordinator to act as the school's representative on a district-wide planning committee. To obtain widespread support, planning should involve parents, community leaders, school and district administrators, and teachers.

**Budget yearly amounts for technology purchases, and plan for sustainability.** Technology changes too rapidly for schools to expect that one-time purchases of equipment or software will suffice. A technology plan should allow for yearly upgrades and additions to keep resources current

and useful. The plan should identify a specific amount to spend each year and a prioritized list of activities to fund over the life of the plan. Schools find that the computers that were new just four years ago cannot run the latest software packages. Funding must address both initial purchases and upgrades needed to sustain schools' technical capacities over time.

**Emphasize teacher training.** Knowledgeable people are as important to a technology plan as up-to-date technology resources. Successful technology programs hinge on well-trained, motivated teachers. A technology plan should acknowledge and address this need with appropriate training activities.

**Match technology to curriculum needs.** Rather than asking, "How can we use this equipment and software?" an effective vision focuses on questions such as these:

- » What are current, unmet educational needs, and can technology address them?
- » What are we teaching now that we can teach better with technology?
- » What can we teach with technology that we could not teach before, but that should be taught?

It is difficult to identify unmet needs since the emergence of new technology has a way of changing them. Many educators did not realize they needed faster communications, for instance, until email and mobile technologies became available. However, technology should become an integral part of new methods to make education more efficient, exciting, and successful.

**Keep current and build in flexibility.** Leading-edge technology solutions can quickly become outdated as new resources and applications emerge. To keep up with these changes, educators must constantly read, and attend conferences, workshops, and meetings. School and district technology plans should address how schools will obtain and use technology resources over a 3- to 5-year period, but should also incorporate new information through annual reviews.

## Essential Condition: Standards and Curriculum Support

NETS for Students, 21st Century Student Outcomes, and the ICT Framework identify higher order thinking skills and digital citizenship as critical for life-long learning and productivity in our emerging global society. Students learn these technology standards in the context of their content-area course work, rather than as a separate subject area. Therefore, it is critical to situate technology skills in content-area curriculum in ways that support both the subject-area content and the technology skills. Fortunately, many content-area standards already address appropriate technology resources and applications, and others seem poised to do so. Thus, this essential condition is met best when technology and content-area standards are designed to support each other.

## Essential Condition: Required Policies

Legal, ethical, and equity conditions in our society profoundly affect educational uses of technology in schools. Effective technology requires school and district policies that ensure appropriate behavior, safety, equitable treatment of all students, financial assistance, incentives, and accountability at all levels of integration. The following policies are required:

**Internet use policies.** The increasing use of the Internet for communications and research also means increased risks for students. Recent statistics (<http://www.netsmart.org/Safety/Statistics>) show that one in 25 young people using the Internet had been approached by predators. (Also see Wolak, Finkelhore, Mitchell, and Ybarra, 2008). The situation is so alarming that the U.S. Congress passed the Children's Internet Protection Act to encourage schools to take measures that keep children away from Internet materials that could be harmful to them (McNabb, 2001). Most schools have students sign

an Acceptable Use Policy (AUP) that stipulates the risks involved in Internet use; outlines appropriate, safe student behavior on the Internet; and asks students if they agree to use the Internet under these conditions and if they agree to certain information about themselves being posted on the school's website.

**Legal/ethical use policies.** Schools also have policies and materials in place to address several common issues, including illegal access to school servers (hacking), viruses, and software/media piracy. Districts usually address illegal access problems by placing firewall software on district and school networks. Firewall software prevents access to specific website addresses or to websites that contain certain keywords or phrases. (Unfortunately, firewalls and filtering software also create a new set of problems for schools by preventing their users from connecting to many legitimate educational sites.) Other districts or schools choose to use commercially available filtering software. Districts and schools also safeguard computers by using virus protection software and posting warnings to students and teachers about the hazards of opening downloaded files.

**Policies to ensure equity.** Schools are also responsible for ensuring equitable access to and use of technology resources by all students, especially those who are traditionally underserved or underrepresented in mathematics, science, and technology occupations.

**Financial assistance, incentives, and accountability policies.** Schools need to support teachers in their efforts to integrate technology effectively. Important aspects of this support include financial assistance for purchasing software for use in their classrooms and attending professional development opportunities; offering incentives to teachers for trying to integrate technology, ranging from monetary incentives to release time; and accountability for teachers who do and do not support district technology initiatives.

## Essential Condition: Access to Hardware, Software, and Other Resources

**Finding funding.** Experts agree that adequate funding can determine the success or failure of even the best technology plans. The summary of guidelines on funding shown in Figure 11 is based on recommendations from Ritchie and Boyle (1998) and Soloman (2001). Schools will never have the budgets for technology that they want or need. Strategies for optimizing available funds include requiring

## FIGURE 11 Funding Sources

Hundreds of sources can be found under each of these five categories: federal, state, corporate, private, and community. The first four usually have budgets for funding larger projects. Schools and teachers usually have smaller projects and seek funding from community sources (e.g., companies, individuals, and groups). General funding sources include:

1. **Federal funding sources:** <http://www.grants.gov>
2. **Sources specific to your state:** Look for links from your state's Department of Education website
3. **Foundations of large companies:** Go to company websites; look for "Funding" links. Examples include:
  - **The Corning Foundation:** [http://www.corning.com/about\\_us/corporate\\_citizenship/community/corning\\_foundation.aspx](http://www.corning.com/about_us/corporate_citizenship/community/corning_foundation.aspx)
  - **Toyota USA Foundation:** [http://www.toyota.com/about/philanthropy/education/toyota\\_usa](http://www.toyota.com/about/philanthropy/education/toyota_usa)
4. **Private foundations:** Examples include:
  - The Annenberg Foundation: <http://www.annenberg-foundation.org>
  - The NEA Foundation: <http://www.neafoundation.org/pages/educators/grant-programs/grant-application>
  - The Bill and Melinda Gates Foundation: <http://www.gatesfoundation.org>
  - Other foundations at: <http://www.fundsnetsservices.com>
5. **Professional education publications:** Examples include:
  - **Edutopia:** <http://www.edutopia.org/grantinfo>
  - **eSchoolNews:** <http://www.eschoolnews.com/funding>
  - **Multimedia & Internet@Schools:** [http://www.mmischools.com/Categories/Grants2c-Funding2c-Free-Resources\\_352.aspx](http://www.mmischools.com/Categories/Grants2c-Funding2c-Free-Resources_352.aspx)
  - **Technology & Learning:** <http://www.techlearning.com/section/Funding>

### GUIDELINES FOR WRITING SUCCESSFUL PROPOSALS

- » **Read and follow the guidelines.** This is the most important guideline of all. Your idea MUST address directly the primary goals of the agency (e.g., some agencies cannot fund equipment; some accept only proposals from K-12 schools, and some only from higher education).

- » **Organize the proposal.** Have: a concise overview (one-to-two pages maximum), a statement of needs the proposal addresses, specific goals and objectives, a narrative summary (as brief as possible), a budget spreadsheet that identifies costs in categories, and a budget narrative that explains the costs.
- » **Write in clear and compelling language.** Ask as many people as possible to read the proposal and suggest changes before you submit it.

### PROPOSAL WRITING COURSES AND TIPS

- » **Short Course:** <http://foundationcenter.org/getstarted/tutorials/shortcourse/index.html>
- » **Other helpful hints:** <http://www.fundraiserhelp.com/grant-writing.htm>

### CHARACTERISTICS OF SUCCESSFUL APPLICANTS

Schools and projects that obtain funding have several characteristics in common:

- » Have ideas for how to make things better.
- » Keep in constant touch with funding opportunities.
- » Foster ongoing relationships with community groups and individuals.
- » Have things already written so they are able to respond quickly when opportunities arise and have one or more good writers handy.
- » Are passionate about their work and know how to describe what they do.

### BUILDING ON SUCCESS

To continue receiving outside funding, educators who have a funded project must do three things on a continuing basis:

1. **Carry out what you proposed.** Show you did good things with what you already received.
2. **Publicize your success.** Publicize through school and district public relations personnel. Create publications and websites to document accomplishments. Ask the local newspaper or TV and radio stations to come for a show-and-tell session. Give talks and presentations to local groups, and get your project on the agendas of school meetings.
3. **Generate new funding opportunities.** View funded projects as seeds for new opportunities rather than one-time activities.

competitive bids, scheduling hardware and software upgrades, using donated equipment, and using broken computers for spare parts.

**Purchasing hardware and software.** Although teachers depend on their schools and district offices to take leadership

in providing necessary resources, teacher input in this process is critically important. When schools and districts make hardware and software purchases, they are making curricular decisions. Therefore, it is important for purchases to begin with those that fulfill the curriculum needs for which teachers most need technology support.

**Setting up and maintaining physical facilities.** Schools have developed several arrangements to help ensure that computer equipment supports teachers' various curriculum needs. Schools can minimize technology repair problems if users follow good usage rules and conduct preventive maintenance procedures. In addition, education organizations usually choose one of the following maintenance options: maintenance contracts with outside suppliers, an in-house maintenance office, built-in maintenance with each equipment purchase, or a repair and maintenance budget. Each of these methods has its problems and limitations, and debate continues over which method or combination of methods is most cost-effective depending on an organization's size and the number of computers and peripherals involved. Securing equipment is an equally important maintenance issue. Loss of equipment from vandalism and theft is a common problem in schools. Again, several options are available for dealing with this problem, including monitoring and alarm systems, security cabinets, and lock-down systems.

## Essential Condition: Skilled Personnel

Most pre-service teacher training programs include at least some preparation in how to integrate technology effectively into teaching. However, because technology resources and applications change so quickly, continuing professional staff development in technology resources and applications remains an essential condition for effective technology integration.

**Hands-on integration emphasis.** Technology integration skills cannot be learned by sitting passively in a

classroom, listening to an instructor, or watching demonstrations. Participants must have an opportunity to navigate through a program and complete a set of steps to create a new product. The focus must be on how to use the technology resources in classrooms rather than just on technical skills.

**Training over time.** The "one-shot" inservice approach is ineffective for helping teachers develop methods to use computers as instructional tools. Inservice training about technology must be ongoing.

**Modeling, mentoring, and coaching.** The most effective teacher educators are those who model the use of technology in their own teaching. One-to-one mentoring and coaching programs and linking teachers to each other and to staff developers have also been shown to be effective. Most teachers seem to learn computer skills through colleague interaction and information sharing.

**Post-training access.** Teachers not only need adequate access to technology during training; they also need immediate access after training to practice and use what they have learned.

## Essential Condition: Technical Assistance

Each teacher needs training in simple troubleshooting procedures, such as what to do if a computer says a disc is "unreadable." Teachers should not be expected to address more complicated diagnostic and maintenance problems, however. Nothing is more frustrating than depending on access to a computer to complete an important student project only to discover that it is broken or malfunctioning. Norris, Sullivan, Poirot, and Soloway (2003) cited limited access to equipment as a major obstacle to effective technology integration, but Lane and Lyle (2011) say that educators' technical expertise and age also play a role. Schools must support teachers by providing and maintaining sufficient equipment designated for classroom use, as well as offering continuing professional development in using technology resources effectively.

## Essential Condition: Appropriate Teaching and Assessment Approaches

Models of technology integration range from relatively passive uses (e.g., teachers reviewing a topic with a *PowerPoint* presentation) to more interactive, hands-on uses (e.g., students using word processing for student reports or calculators for supporting mathematics problem solving, doing



Technology integration strategies can address specific instructional needs identified by educational theorists and practitioners, but continuing professional staff development is an essential condition for effective technology integration.

Photo by W. Wiencke.

Internet searches for research, or creating hypermedia products to communicate research findings). Each technology integration strategy is appropriate depending on the instructional need, and teachers should be encouraged to use all of them. Assessment practices will vary with the technology integration model. The critical factor is matching the teaching strategy with an appropriate assessment strategy. For example, if students are creating web pages, a grading rubric would measure their achievement better than a traditional written test would. Depending on the integration model, teachers may want to use a combination of assessment strategies (e.g., written tests as well as products evaluated with a rubric).

## Essential Condition: Engaged Community

Technology has the most impact on achieving educational goals when schools involve the entire local community. This means holding public forums about technology initiatives, bringing community members into the classroom, educating those who can play key roles, and fostering partnerships among schools, businesses, corporations, individual entrepreneurs, and educators. Businesses often partner with school programs to make a dream a reality. This is not only a way to extend school technology budgets, it brings many talents together to work toward a common purpose: school improvement.



## SUMMARY

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

### 1. Overview of factors in successful technology integration—

Three interrelated factors help ensure effective technology integration: learning theory foundations; an integration planning model that includes teachers' Tech-PACK, or optimal combination of content knowledge, pedagogical technology, and technology knowledge; and essential conditions for integration.

**2. Overview of learning theory foundations—**Two lines of learning theories have given rise to two types of integration models: directed and constructivist.

- » Directed integration models were shaped by objectivist theories: behaviorist (Skinner), information-processing (Atkinson and Shiffrin), cognitive-behavioral (Gagné), and systems theories.
- » Constructivist models were shaped by constructivist theories: social activism (Dewey), social learning (Bandura), scaffolding (Vygotsky), child development (Piaget), discovery learning (Bruner), and multiple intelligences (Gardner) theories.

**3. Technology integration strategies based on directed models include—**Integration to remedy identified weaknesses or skill deficits; integration to promote skill fluency or automaticity; integration to support efficient, self-paced learning; and integration to support self-paced review of concepts.

**4. Technology integration strategies based on constructivist strategies include—**Integration to foster creative problem

solving and metacognition; integration to help build mental models and increase knowledge transfer; integration to foster group cooperation skills; and integration to allow for multiple and distributed intelligences.

**5. Technology integration strategies based on either model—**Integration to generate motivation to learn; integration to optimize scarce resources; integration to remove logistical hurdles to learning; and integration to develop information literacy and visual literacy skills.

**6. The Technology Integration Planning (TIP) Model—**This model is designed to help teachers (especially those new to technology) plan for effective classroom uses of technology. The model consists of seven steps within three phases:

- » Phase 1: Analysis of Learning and Teaching Needs
- » Phase 2: Planning for Integration
- » Phase 3: Post-instruction Analysis and Revisions

**7. Essential conditions for technology integration—**For technology to have the desired impact on improved teaching and learning, the following conditions must be in place: a shared vision for technology integration; standards and curriculum support; required policies; access to hardware, software, and other resources; skilled personnel; technical assistance; appropriate teaching and assessment approaches; and an engaged community.





# 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. In their anti-constructivism article, "We Want to See the Teacher," in the *Phi Delta Kappan*, Baines and Stanley (2000) say, "The teacher as a 'sage on the stage' has been tossed aside in favor of the learning facilitator, more commonly known as a 'guide on the side.' In the constructivist view, memorization of multiplication tables, poetry, dates of historical importance, or scientific formulas is decried as 'mindless' and even 'hegemonic.' Indeed, in the current educational climate, the worst insult that can be leveled at a teacher is that a lesson involves 'rote learning'" (p. 328). What evidence can you cite that this is or is not an accurate characterization of constructivism in practice?
2. Read Cory's brief article, "The poor scholar's soliloquy," at <http://www.questia.com/PM.qst?a=o&d=27849895>. This piece was written in 1944. Is the situation the boy describes still typical of American education? Can you cite ways in which more constructivist approaches could benefit this child?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

From your work in this chapter, include in your portfolio your Tech-PACK reflection and the product from your group's Hot Topic Debates for Class Discussion.

## 2. TECH-PACK IN ACTION: ANALYZE A SCENARIO

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Read again the Technology Integration Example that served to illustrate the TIP Model in this chapter.

- a. Deconstruct Mia's Tech-PACK in the following way: Fill in the following matrix to show what she appears to know and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

# 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.

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# INSTRUCTIONAL SOFTWARE FOR 21ST CENTURY TEACHING

# INSTRUCTIONAL SOFTWARE FOR 21ST CENTURY TEACHING

The fact that individuals bind themselves with strong emotional ties to machines ought not to be surprising. The instruments [we] use become . . . extensions of [our] bodies.

Joseph Weizenbaum, *Computer Power and Human Reason* (1976, p. 9)

## o u t c o m e s

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

1. Classify a given product or system as to whether it does or does not qualify as instructional software, and choose from a list the roles it can play in teaching and learning, as well as the configurations required to fulfill these roles.
2. For a given drill-and-practice software product, create a set of lesson activities that accurately reflects each of the roles it can play in teaching and learning.
3. For a given tutorial software product, create a set of lesson activities that accurately reflects each of the roles it can play in teaching and learning.
4. For a given simulation software product, create a set of lesson activities that accurately reflects each of the roles it can play in teaching and learning.
5. For a given instructional game software product, create a set of lesson activities that accurately reflects each of the roles it can play in teaching and learning.
6. For a given problem-solving software product, create a set of lesson activities that accurately reflects each of the roles it can play in teaching and learning.
7. Classify a given product or system as to whether it does or does not qualify as an integrated learning system, and choose from a list the roles it can play in teaching and learning.



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## key terms

automaticity  
computer-assisted  
instruction (CAI)  
courseware  
drill and practice

instructional game  
instructional software  
integrated learning  
systems (ILSs)  
intelligent tutoring systems

Logo  
problem solving  
problem-solving software  
simulation  
tutorial



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## TECHNOLOGY INTEGRATION IN ACTION: **MATH BY DESIGN**

GRADE LEVEL: Middle school • CONTENT AREA/TOPIC: Geometry and measurement • LENGTH OF TIME: Two weeks

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage

Ms. Paige was a veteran middle school mathematics teacher who had won awards for her teaching and was highly regarded in her district. She was always able to get a high percentage of her students to pass required state tests, yet she continued to struggle with engaging them in geometry skills. She was always looking for examples to show her students practical applications of geometry concepts in everyday life, but each year she taught she found students were increasingly disinterested. Though they were learning geometry skills and passing tests, she doubted they would remember the concepts or be able to connect these skills to practical problems and situations in the world around them.

One day she attended a professional development workshop on new resources available from the state's websites to support teaching Science, Technology, Engineering, and Mathematics (STEM) subjects. She learned of a curriculum project called Math by Design, in which students solved geometry and measurement problems by becoming "junior architects" and redesigning a park in an imaginary town called Flossville. She thought that these hands-on activities that required applying

geometry skills in a fun environment might have relative advantage, since they could stir students' interest more than just seeing examples. She decided to integrate these web-based problem-solving activities into her geometry instruction.

#### Step 2: Assess Tech-PACK

**Technology Domain.** She realized that before she could incorporate these new materials into her lessons, she had to know a great



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deal about the resources the website had to offer, how each one worked, and how Flossville activities were organized. She spent several hours reviewing the materials and working through each of the unit's six design problems.

**Content and Pedagogy Domains.** Though she believed herself very competent in geometry content, she reflected on how she would have to teach each of the geometry skills in a way that would help students connect them with Flossville design tasks. It made her think about how to sequence and assess concepts in a much different way than she had been used to doing, but she found the website's teaching hints and sample lessons most helpful. She had never worked with a website project before, but she found the site easy to use and intuitive. After her review and reflection, she felt ready to begin planning.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments

Ms. Paige also realized that she wanted her students to achieve more with these materials than just passing tests. She wanted the experience to be interesting and challenging in ways that would change their attitudes about geometry. She developed the following outcomes, objectives, and assessments that would help her determine later if she had accomplished her aims:

- » **Outcome:** Select and use appropriate geometry concepts to solve graphic design problems. **Objective:** All students,

working in groups, will create correct solutions for assigned Flossville design problems. **Assessment:** Score at least 20 out of 25 on a teacher-designed rubric assessing group work and design solutions.

- » **Outcome:** Transfer geometry skills from Flossville to teacher-designed situations. **Objective:** All students, working individually, will achieve a score of at least 80% on a post-unit test requiring transfer of geometry concepts covered in Flossville to novel design scenarios. **Assessment:** Teacher-designed, multiple-choice test of 12 scenario items (two scenario items per geometry concept).
- » **Outcome:** Demonstrate achievement of state geometry standards. **Objective:** All students will achieve at least a passing score (80%) on the state-required post-course geometry test. **Assessment:** State multiple-choice, post-course geometry exam.
- » **Outcome:** Enjoy learning geometry skills and appreciate their value. **Objective:** At least 90% of students will demonstrate improved attitudes toward learning geometry skills. **Assessment:** A teacher-designed, ten-item survey that students complete anonymously.

### Step 4: Design integration strategies

Ms. Paige decided that students would find the Math by Design materials most motivating if they did the design tasks themselves using the hints and tutorial explanations; she would provide very little direct instruction. Even though the site was really a problem-solving environment, the site had a game-like feel to it, so she resolved to introduce it as a game that students could play as a reward for learning geometry skills. She also felt they would do well with this project after she had taught several of the prerequisite geometry skills, so she would introduce the Flossville activity later in the course. With these aspects in mind, she created the following activity sequence:

- » **Day 1:** Introduce to the whole class the environment and its design tasks and illustrate on the whiteboard how to access the hints, calculator, and other features. Tell them that, using the two computers in the classroom, they will work in two pairs or groups of three to solve an assigned design task. Each set of two groups would become "expert" in one of the design tasks and the skills and procedures required to solve them. Then, when the class was able to go to the computer lab, students would work individually on all design tasks, one

## AN INTRODUCTION TO INSTRUCTIONAL SOFTWARE

At the same time that people began to realize that computers could help them do many clerical tasks more quickly and accurately, they also began thinking, "If computer programs can be created to do essentially anything, why not

program computers to teach?" Educators and developers alike began to pursue this idea in the 1960s and 1970s. Some, like William Norris (1977), who developed Control Data's PLATO teaching system, believed that computer-based education was the only logical alternative to education's "outdated, labor-intensive ways" (p. 451). He felt that education would be more efficient if computers took over the traditional role of teachers.

at a time, with the “experts” on each task assisting them. Each “expert” would be expected to know the design task well enough to answer any questions other students might have. Students would also complete a pre-assessment of geometry attitudes using the survey she had created.

- » **Days 2-6:** The groups begin their work in the classroom. While they work on the Math by Design site, the other students work on assigned review activities and complete makeup work from the previous unit.
- » **Days 7-9:** The whole class goes to the computer lab to work on the other design tasks they have not yet completed. The students act as experts and assist other students with the design tasks.
- » **Day 10:** The class completes the post-project assessment and geometry attitudes survey.

### Step 5: Prepare instructional environment

Ms. Paige knew that working with technology materials required some additional planning, so she did the following to make sure everything needed for the project was in place:

- » **Materials:** She made a chart showing which students were assigned to be experts on each of the six design tasks. She also made notes on which geometry skills were required for each task so she could be sure she covered these in her instruction and reviews before students began working with Math by Design. She set up a schedule for which groups would work on her classroom computers each day.
- » **Computer scheduling:** The computer lab was much in demand for students’ general production work (e.g., word processing) and work for other classes, so she met with the computer lab director and explained the project to her before requesting use of the lab for a three-day period.
- » **Parent letter:** The Math by Design website provided a letter to send home to parents about the project. She thought it was a good idea to let parents know what students were doing, so she printed out the letters for students to take home. She also posted a copy of the letter on her page on the school’s website.
- » **Backup plans:** She knew that the computer lab sometimes closed unexpectedly due to technical issues, so she decided to make some “just-in-case” plans. She decided her

backup plan would be to show the whole class one or more of the short Math in Action videos on the Math by Design website, hold a discussion using the questions the site provided, and follow up by having students work the practice problems the site offered to support each video.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

Ms. Paige was delighted with the students’ obvious enthusiasm for the Math by Design activities. They especially liked being named experts on a design task and helping “teach” other students how to do it. Some of the students began to bring in and share their own examples of geometry principles and examples they had identified outside the classroom, and the geometry attitudes survey reflected a definite pre-to-post improvement. A couple students asked if she had materials on careers in architecture. The only real problem she noticed was that one of the design tasks was more difficult than others and the “student experts” assigned to it required more teacher assistance. Also, on the post-assessment she had created to determine if students could transfer what they had learned to design situations similar to Flossville, she found that some of the geometry skills transferred more than others. There was no difference in the number of students passing the end-of-course geometry test, but that did not surprise her, since most usually passed it.

### Step 7: Make revisions.

Ms. Paige made a note to remember to assign the one more-difficult design task to her best students. She made a note that more review and discussion was necessary before students took the post-assessment. She decided that she would use the Math in Action videos to support this review and help students remember what they had learned. Several students asked if they could do more activities like the Flossville project, so she decided to include the other Math by Design environment, the Windjammer Environmental Center, in her curriculum. She asked the computer lab director if she could use the bulletin board in the lab to display printouts from the Flossville environment and describe the geometry standards students had achieved.

Today, after more than 30 years of development and experimentation, there is less talk of computers replacing teachers and more about helping teachers perform various tasks in ways that transform the teaching process. This chapter shows how software empowers teachers, rather than replaces them. This section introduces basic definitions and terms for instructional software, outlines the roles these products can play in teaching and learning, and

describes configurations that characterize today’s products and systems.

## Instructional Software Defined

**Instructional software** is a general term for computer programs designed specifically to deliver instruction or assist with the delivery of instruction on a topic. Although tool



software, such as word processing and spreadsheets, can also enhance instructional activities text, this differentiates between tool software and instructional software. Software tools serve many purposes other than teaching; instructional software packages are developed for the sole purpose of supporting instruction and/or learning.

A few programming languages were designed especially for educational purposes and thus may be considered hybrid software, since they merge the capabilities of instructional and tool software. One of the most widely known of the programming languages used for instruction is Logo. **Logo** introduces young children to problem solving through programming and allows them to explore concepts in content areas such as mathematics, science, and language arts (Galas, 1998; Gonsalves & Lopez, 1998; Weinstein, 1999). The work of Seymour Papert (1980) and his colleagues at the Massachusetts Institute of Technology made Logo “widely used throughout the world as an introductory programming language and mathematical learning environment for students in elementary and secondary schools” (Watt, 1992, p. 615). Although not as popular





as in the 1980s, Logo and some of its derivative materials are still used for instructional purposes.










In the early days—when instructional software was used primarily to tutor students—it was called **computer-assisted instruction (CAI)** or **courseware**. The term is still in common use, but some kinds of instructional software are designed with more constructivist purposes in mind; they support, rather than deliver, instruction. Therefore, teachers also may hear instructional software referred to as computer-based instruction (CBI), computer-based learning (CBL), or computer-assisted learning (CAL), or in more generic terms, such as software learning tools.

## The Roles of Instructional Software in Teaching

It used to be easy to classify a software package by the type of teaching function it served—drill-and-practice, tutorial, simulation, instructional game, or problem-solving program. (See descriptions in Table 1.) But many of today’s

**TABLE 1** Five Instructional Software Functions

Software Function and Example	Description of Functions	Type of Strategy	
		Directed	Constructivist
<p><b>Drill and Practice</b></p>  <p>BrainPop: <a href="http://www.brainpopesl.com/level1/unit4/lesson1/warmup">http://www.brainpopesl.com/level1/unit4/lesson1/warmup</a></p>	<p>Allows learners to work problems or answer questions and get feedback on correctness.</p>		
<p><b>Tutorial</b></p>  <p>ETCAI: <a href="http://etcai.com/index.html">http://etcai.com/index.html</a></p>	<p>Acts like a human tutor by providing all the information and instructional activities a learner needs to master a topic: information summaries, explanation, practice routines, feedback, and assessment.</p>		

Software Function and Example	Description of Functions	Type of Strategy	
		Directed	Constructivist
<p><b>Simulation</b></p>  <p>Digital Frog: <a href="http://www.digitalfrog.com">http://www.digitalfrog.com</a></p>	Models real or imaginary systems to show how those systems or similar ones work or to demonstrate underlying concepts.		
<p><b>Instructional Game</b></p>  <p>iCivics: <a href="http://icivics.org">http://icivics.org</a></p>	Increases motivation by adding game rules to drills or simulations.		
<p><b>Problem Solving</b></p>  <p>Memory Challenge: <a href="http://www.criticalthinking.org">http://www.criticalthinking.org</a></p>	<p>(a) Teaches directly (through explanation and/or practice) the steps involved in solving problems or</p> <p>(b) helps learners acquire problem-solving skills by giving them opportunities to solve problems.</p>		

Source: Images reprinted by permission of BrainPop, ETCAI, Digital Frog International, Inc., iCivics Inc., and The Critical Thinking Company. Brain Pop © 1999–2011. All rights reserved.

software packages or systems fulfill several different functions. For example, a language-learning system may have a number of straight drill activities, along with activities that fulfill problem-solving and game functions. It is important to note that developers often use the terms for these functions interchangeably, and there is no consensus among developers about the defining characteristics of each type of program. Some developers refer to a drill program that gives extensive feedback as a tutorial. Others refer to simulations or problem-solving functions as games.

Software still reflects the same five functions, but in light of current trends toward multiple-function software systems, teachers must analyze a package carefully to determine which instructional function(s) it serves so as to ensure it supports their specific teaching needs. They may not be able to refer to an entire package as a drill or a simulation, but it is possible and desirable to identify whether it provides, for example, science vocabulary skill practice and/or opportunities for studying plant growth in action. As this chapter will show, each software function serves a different purpose during learning and, consequently, has its own appropriate integration strategies.

The first instructional software reflected the behavioral and cognitive learning theories that were popular at the time. Some software functions (e.g., drill and practice, tutorial) remain focused on directed strategies that grew out of these theories, delivering information to help students acquire and retain information and skills. Later, instructional software was designed to support the more constructivist aims of helping students explore topics and generate their own knowledge. Therefore, some software functions (e.g., simulation, games) can be used in either directed or constructivist ways, depending on how they are designed. See Table 1 for a summary of the five software functions described in this chapter.

Gagné, Wager, and Rojas (1981) suggested a way to look at software that can help educators analyze a given product with respect to its instructional function(s) and design appropriate integration strategies that make use of these functions. Gagné et al. said that drills, tutorials, and simulations each accomplish a different combination of the Events of Instruction. The nine events are guidelines identified by Gagné that can help teachers arrange optimal “conditions for learning” for various types of knowledge and skills. By determining which



**TOP TEN**  
**Integration Strategies for Instructional Software**

The ten uses for instructional software given here are among the most popular described in the literature.

SOURCE	TRACK	SELECTION
Simulation software	<b>1</b>	Use simulation software, such as The Digital Frog International's online Digital Frog ( <a href="http://www.digitalfrog.com/products/frog.html">http://www.digitalfrog.com/products/frog.html</a> ), to replace or supplement hands-on dissections to help teach anatomy.
Thinkport's free online resources	<b>2</b>	Employ one or more resources ( <a href="http://www.thinkport.org/Classroom/stem.tp">http://www.thinkport.org/Classroom/stem.tp</a> ) to support science, technology, engineering, and mathematics (STEM) classroom activities.
<i>Geometer's Sketchpad</i>	<b>3</b>	Let students explore geometric principles and proofs using Key Curriculum Press's <i>Geometer's Sketchpad</i> ( <a href="http://www.keypress.com/x24070.xml">http://www.keypress.com/x24070.xml</a> ).
Physics Classroom	<b>4</b>	Have students use physics tutorials in the free online Physics Classroom ( <a href="http://www.physicsclassroom.com/Class/index.cfm">http://www.physicsclassroom.com/Class/index.cfm</a> ) to review content following lectures or as a way to study for physics exams.
Stock market software	<b>5</b>	Give students insight into how the stock market works by practicing "investing" online for free ( <a href="http://www.nationalsms.com">http://www.nationalsms.com</a> and <a href="http://www.howthemarketworks.com">http://www.howthemarketworks.com</a> ).
BrainPop	<b>6</b>	Provide practice in using English language words and phrases for ESL students with BrainPop's animated exercises ( <a href="http://www.brainpopesl.com">http://www.brainpopesl.com</a> ).
Congress for Kids	<b>7</b>	Let students review information about how the U.S. government works by using the free online Congress for Kids site ( <a href="http://congressforkids.net">http://congressforkids.net</a> ).
Practice for high-stakes tests	<b>8</b>	Help students prepare for high-stakes tests, such as the SAT or ACT, by using drill-and-practice software, such as the Princeton Review ( <a href="http://www.princetonreview.com">http://www.princetonreview.com</a> ), or online sites, such as the Online Test Page ( <a href="http://www.saab.org/saab_org.cgi">http://www.saab.org/saab_org.cgi</a> ).
Foreign language software	<b>9</b>	Have students practice their foreign language skills with software that includes audio feedback, such as Rosetta Stone's drill software ( <a href="http://www.rosetastone.com">http://www.rosetastone.com</a> ) or Quia's free, online drill exercises ( <a href="http://www.quia.com/web">http://www.quia.com/web</a> ).
Tutorial Instructional Sequences	<b>10</b>	Use tutorial instructional sequences, such as those at Carnegie Learning's Cognitive Tutor ( <a href="http://www.carnegielearning.com">http://www.carnegielearning.com</a> ), to give students detailed reviews of math skills or to let advanced students surge ahead.



of the events a software package fulfills, he said, educators can determine the teaching role it serves and where it might fit in the instructional process. However, Gagné's approach was primarily for directed uses, rather than constructivist uses. This

chapter describes both kinds of strategies for instructional software. Look for integration strategies and examples for each of the five software functions. Also, see a summary of Top Ten Integration Strategies for Instructional Software on this page.

## Current Instructional Software Configurations

Although instructional software resources have been around since the 1960s, the following are the most recent developments in their features and uses:

- » **Online access and multi-platform use**—Teachers used to purchase software in the form of off-the-shelf media. They bought programs on disc and either ran them from the disc or transferred programs from disc to computer. Today, most software is accessed on the Internet and does not need to reside in the computer. There are many sources of free software. (See also Open-Source Options.) Also, programs can now be used from virtually any Internet-enabled device (e.g., a microcomputer, handheld device, or cell phone). Allowing access to software for all students remains an issue. See the Adapting for Special Needs topic for how to address this concern.
- » **Multimedia and game formats**—Software design and development have evolved from offering simple, one-dimensional products to providing multimedia experiences and environments to engage students. Many of the new products are designed to capitalize on the popularity of video games and, like these games, are structured with limited direction; students must figure out how to make them work.
- » **Renewed emphasis on directed strategies**—The recent emphasis on educational accountability and meeting standards (e.g., the No Child Left Behind Act [NCLB]) has breathed new life into strategies that were once considered passé. Even in research circles, some authors have claimed that directed teaching strategies are more effective than minimally guided teaching techniques (Kirshner, Sweller, & Clark, 2006). As constructivist methods became more popular in the 1980s and 1990s, the demand for drill-and-practice and tutorial instructional software waned, and use of simulation and problem-solving software increased. Now, directed strategies that drills and tutorials support—strategies that are ideal for preparing students for tests—are once again on the rise. The same accountability emphasis has created a demand for instructional software products sometimes called integrated learning systems (ILSs), which are networked or online systems that provide both computer-based instruction and track and report on student progress (see section later in this chapter). These systems are an efficient way for many students to access instructional software from a central source (e.g., a school or district server), and educators often employ them to support directed instruction for remedial

programs (e.g., Title III programs that provide special resources for disadvantaged students).

## DRILL-AND-PRACTICE TEACHING FUNCTIONS

**Drill-and-practice** software functions provide exercises in which students work example items, usually one at a time, and receive feedback on their correctness. Programs vary considerably in the kind of feedback they provide in response to student input. Feedback can range from a simple display like “OK” or “No, try again” to elaborate animated displays or verbal explanations. Some programs simply present the next item if the student answers correctly.

Types of drill and practice are sometimes distinguished by how the program tailors the practice session to student needs (Merrill & Salisbury, 1984). Types of drill functions, described below, include flash card activities, chart activities, branching drills, and extensive feedback activities:

- » **Flash card activity**—This is the most basic drill-and-practice function, arising from the popularity of real-world flash cards. A student sees a set number of questions or problems, presented one at a time. The student chooses or types an answer, and the program responds with positive or negative feedback depending on whether the student answered correctly.
- » **Chart fill-in activities**—In this kind of practice, students are asked to complete a whole set of answers (e.g., multiplication facts) by filling in a chart, usually on a timed basis to test for fluency. Then they receive feedback on all the answers at once.
- » **Branching drill**—This is a more sophisticated form of drill and practice. In branching drills, the software



A popular use of drill software is helping students prepare for high-stakes tests.  
Photo by W. Wiencke.

# Free open source **OPTIONS** for Instructional Software Sites

## TYPES

## FREE SOURCES

### Drill and practice

Drills in SAT, vocabulary and math: [http://www.saab.org/saab\\_org.cgi](http://www.saab.org/saab_org.cgi)  
 Drills in multiplication tables: <http://www.resourceroom.net/math/1timestables.asp#practice>  
 Drills in chemistry: <http://www.chemistry-drills.com>  
 Drills in music concepts: <http://www.emusictheory.com/practice.html>  
 Drills in language arts skills: [http://www.sheppardsoftware.com/web\\_games\\_vocab.htm](http://www.sheppardsoftware.com/web_games_vocab.htm)  
 Drills in history and geography concepts: <http://tutorial.teachtci.com>  
 Drills in math concepts: <http://math.rice.edu/~lanius/Lessons>  
 Self-test drills for English language learners: <http://www.englishlearner.com/tests/index.shtml>  
 Flash card creation site: <http://quizlet.com>

### Tutorial

Technology how-to tutorials: <http://www.internet4classrooms.com/on-line2.htm>  
 Physics tutorials: <http://www.physicsclassroom.com/Class/index.cfm>  
 Economics tutorials: <http://hadm.sph.sc.edu/Courses/Econ/tutorials.html>  
 Chemistry tutorials: <http://www.chemcollective.org/tutorials.php>  
 Math tutorials: <http://math.rice.edu/~lanius/Lessons>  
 U.S. government tutorials: <http://congressforkids.net>

### Simulations

Stock market simulation for schools: <http://www.nationalsms.com>  
 (\$12 registration fee)  
 Stock market simulation: <http://www.howthemarketworks.com>  
 Chemistry simulations: <http://www.chemcollective.org/applets/vlab.php>  
 Social studies simulations: <http://www.socialstudiescentral.com/?q=content/online-interactive-simulations>  
 Genetics simulations (GenScope): <http://genscope.concord.org>

### Instructional games

Social studies games: <http://playinghistory.org>  
 Civics games: <http://www.icivics.org>  
 Science games: <http://www.educational-freeware.com/category-Science.aspx>  
 Brain Games: <http://www.sheppardsoftware.com/braingames/braingames.htm>  
 Game collection: <http://www.gameclassroom.com>  
 Jeopardy game-maker and library: <http://www.superteachertools.com/jeopardy>

### Problem solving

Memory Challenge: <http://www.criticalthinking.com>  
 Thinkport-STEM Collaborative: <http://www.thinkport.org/Classroom/stem.tp>  
 Triana Open-Source Problem Solving Environment: <http://www.trianacode.org>

Information found at <http://www.educational-freeware.com>



# ADAPTING FOR SPECIAL NEEDS

## Instructional Software

When selecting instructional software for the classroom, teachers, technology specialists, and administrators should be mindful of special needs that may impact access and engagement. For example, some students may not be able to use the standard mouse and keyboard due to physical disabilities that impair gross and fine motor movement. In these situations, schools will need to provide items such as the following that allow an individual with a special need to operate the computer with adaptive equipment:

- » **Expanded keyboards:** [http://www.gokeytech.com/intellikeys\\_usb\\_keyboard.htm](http://www.gokeytech.com/intellikeys_usb_keyboard.htm)
- » **Keyboards with guards:** <http://www.enablemart.com/Catalog/Alternative-Keyboards/Maltron-Expanded-Keyboard>
- » **Adaptive switch interfaces:** <http://www.enablemart.com/Catalog/Switch-Interfaces>

Students with sensory impairments may be unable to access software that has not been properly designed to be accessible. Students who are blind use screen reading software (see JAWS below) to read them the information on the screen. Be sure to ask the vendor if the software is compatible with screen readers such as JAWS. Students who are deaf will not

be able to access information presented in audio format unless the audio is captioned or a text transcript is available (see captioning how-to guide below).

- » **JAWS:** <http://www.freedomscientific.com/products/fs/jaws-product-page.asp>
- » **Creating captions how-to guide:** <http://jdfrey.wordpress.com/2006/11/02/podcast-captioning>

Finally, students with cognitive disabilities will encounter difficulty using software that has extensive commands and complex interfaces. In these situations, look for software such as the following that offers simplified user interfaces:

- » **Scholastic Keys:** <http://www.tomsnyder.com/products/product.asp?sku=keykey>
- » **Inspire Data:** <http://www.inspiration.com/InspireData>

**For more about accessible software, see:**  
[http://msdn.microsoft.com/en-us/library/aa291864\(v=vs.71\).aspx](http://msdn.microsoft.com/en-us/library/aa291864(v=vs.71).aspx)

*Contributed by Dave Edyburn*

moves students on to advanced questions after they get a number of questions correct at some predetermined mastery level; it may also send them back to lower levels if they answer a certain number wrong. Some programs automatically review questions that students get wrong before going on to other levels. Students may not realize that branching is happening, since the program may do it automatically without alerting them to this fact. Sometimes, however, the program may congratulate students on good progress before proceeding to the next level, or it may allow them to choose their next activities.

- » **Extensive feedback activities**—In these drills, students get more than just correct/incorrect feedback. Some programs give detailed feedback on why the student got a problem wrong. This feedback is sometimes so thorough that the software function is often mistaken for a tutorial. (See the next section for a description of tutorial functions.) However, the function of a drill is not instruction, but rather practice after instruction. Consequently, the integration strategies for drill and tutorial functions differ.

## Selecting Good Drill-and-Practice Software

In addition to meeting general criteria for good instructional software, well-designed drill-and-practice programs should also meet specific criteria:

- » **Control over the presentation rate**—Unless the questions are part of a timed review, students should have as much time as they wish to answer and examine the feedback before proceeding to later questions. A student usually signals readiness to go to the next question by simply pressing a key.
- » **Answer judging**—If programs allow students to enter a short answer rather than simply choosing one, a good drill program must be able to discriminate between correct and incorrect answers.
- » **Appropriate feedback for correct and incorrect answers**—If students' responses are timed, or if their session time is limited, they may find it more motivating simply to move quickly to the next question, rather than receiving recognition for correctness. When drills

do give feedback, they must avoid two common errors. First, feedback must be simple and display quickly. Students rapidly tire of elaborate displays, and the feedback ceases to motivate them. Second, some programs inadvertently motivate students to get wrong answers by giving more exciting or interesting feedback for wrong answers than for correct ones. The most famous example of this design error occurred in an early version of a popular microcomputer-based math drill series. Each correct answer got a smiling face, but two or more wrong answers produced a full-screen, animated crying face that students found amusing. Consequently, many students tried to answer incorrectly so they could see it. The company corrected this flaw, but this classic error still exists today in other programs.

## Benefits of Drill and Practice

Though drill-and-practice software is often disparaged by constructivists as “drill and kill,” the benefits of this software function have been well-established by research. Indeed, its effects were so well documented in the early days of computer-based learning that it is not a topic of much current research. It became clear that drill activities can allow the effective rehearsal students need to transfer newly learned information into long-term memory (Merrill & Salisbury, 1984; Salisbury, 1990). To help them master higher order skills more quickly and easily, students must have what Gagné (1982) and Bloom (1986) call **automaticity**, or automatic recall of lower order prerequisite skills. The usefulness of drill programs in providing this kind of practice has been well documented, but the programs seem especially popular among teachers of students with learning disabilities (Hasselbring, 1988; Higgins & Boone, 1993; Okolo, 1992).

In a more recent study, Schoppek and Tulis (2010) noted that, “The fluency of basic arithmetical operations is a precondition for mathematical problem solving. However, the training of skills plays a minor role in contemporary mathematics instruction” (p. 239). Their results with third graders showed that even a moderate amount of individualized practice with drill software greatly improved both arithmetic skills and problem solving, an impact that continued in follow-up testing three months later. The researchers felt that individualized practice with drill software was a more efficient use of time than other kinds of practice. Action research studies (Darling, 2000; Williams, 2000) have also reported that drill software yields equivalent or better benefits when compared to paper-pencil practice, while noting that drill software is both more efficient and often more appealing to students.

Although curriculum increasingly emphasizes problem solving and higher order skills, teachers still give students on-paper practice (e.g., worksheets or exercises) for many

skills to help them learn and remember correct procedures. Kahn (1998–1999) reports the following acknowledged benefits of drill software as compared to paper exercises:

- » **Immediate feedback**—When students practice skills on paper, they frequently do not know until much later whether or not they did their work correctly. To quote a common saying, “Practice does not make perfect; practice makes permanent.” As they complete work incorrectly, students may actually be memorizing the wrong skills. Drill-and-practice software informs them immediately whether their responses are accurate so they can make quick corrections. This helps both “debugging” (identifying errors in their procedures) and retention (placing the skills in long-term memory for future access).
- » **Motivation**—Many students refuse to do the practice they need on paper, either because they have failed so much that the whole idea is abhorrent, they have poor handwriting skills, or they simply dislike writing. In these cases, computer-based practice may motivate students to do the practice they need. Computers don’t get impatient or give disgusted looks when a student gives a wrong answer.
- » **Saving teacher time**—Since teachers do not have to present or grade drill and practice, students can practice on their own while the teacher addresses other student needs. The curriculum has dozens of areas in which the benefits of drill and practice apply. Some of these are:
  - Math facts
  - Typing skills
  - English and foreign-language vocabulary
  - Countries and capitals
  - Preparation for SAT, ACT, TOEFL, and other high-stakes tests
  - Musical keys and notations

## Limitations and Problems Related to Drill and Practice

Although drill and practice can be extremely useful to both students and teachers, it is also frequently maligned by its critics as “drill and kill.” This criticism comes from the following two sources:

- » **Perceived misuses**—Some authors have criticized teachers for presenting drills for overly long periods or for teaching functions that drills are ill suited to accomplish. For example, teachers may give students

drill-and-practice software as a way of introducing new concepts rather than just for practicing and reinforcing familiar ones.

- » **Criticism by constructivists**—Since it is identified so closely with traditional instructional methods, drill-and-practice software has become an icon for what many people consider an outmoded approach to teaching. Critics claim that introducing isolated skills and directing students to practice them contradicts the trend toward restructured curriculum in which students learn and use skills in an integrated way within the context of their own projects that specifically require the skills.

some time to come. Rather than ignoring drill-and-practice software or criticizing it as outmoded, teachers should seek to identify needs that drills can meet and use the software in ways that take advantage of its capabilities. See Figure 1 for examples of drill software and a summary of drill features.

## Using Drill and Practice in Teaching

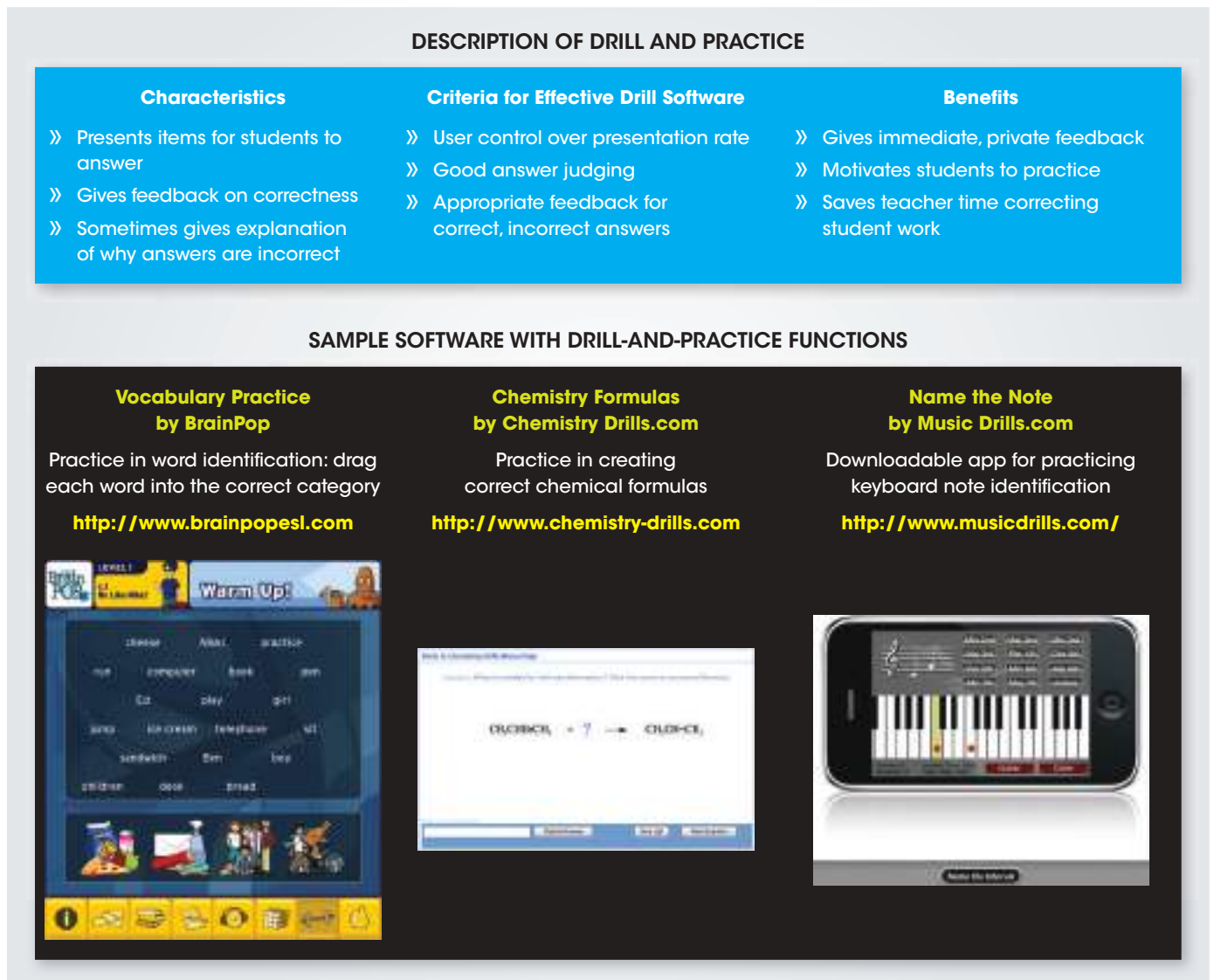
Drill-and-practice software can serve several classroom needs. This section describes integration strategies to meet each of these needs and offers guidelines and practical tips on how to integrate these strategies in the classroom.

### Classroom integration strategies for drill functions.

Drill-and-practice programs may be used whenever teachers

Despite these criticisms, it is likely that some form of drill-and-practice software will be useful in many classrooms for

**FIGURE 1 Drill-and-Practice Software Functions in Brief**



Source: Images reprinted by permission of BrainPop, Meta-Synthesis, and Music Drills. BrainPop © 1999–2011. All rights reserved.



feel the need for on-paper exercises such as worksheets. On some occasions, even the most creative and innovative teacher may take advantage of the benefits of drill-and-practice software to give students practice using isolated skills. Integration strategies include:

- » **Supplement or replace worksheets and homework exercises**—Whenever students have difficulty with higher order tasks ranging from reading and writing to mathematics, teachers may have to stop and identify specific prerequisite skills that these students lack and provide the instruction and practice they need to go forward. In these cases, learning may require a rehearsal activity to make sure information is stored in long-term memory so students can retrieve it easily. Drills’ motivation, immediate feedback, and self-pacing can make it more productive for students to practice required skills on the computer than on paper.
- » **Prepare for tests**—Despite the new emphasis on student portfolios and other authentic assessment measures, students can expect to take several kinds of objective examinations in their education careers. When they need to prepare to demonstrate mastery of specific skills in important examinations (e.g., for end-of-year grades or for college entrance), drill-and-practice software can help them focus on their deficiencies and correct them. An example integration strategy for drill functions is shown in Technology Integration Example 1.

**Guidelines for using drill and practice.** Use the following guidelines to make the best use of drill capabilities when designing integration strategies for drill-and-practice functions:

- » **Set time limits**—Teachers should limit the time devoted to drill assignments to 10 to 15 minutes per day. This ensures that students will not become bored and that the drill-and-practice strategy will retain its effectiveness. Also, teachers should be sure students have been introduced previously to the concepts underlying the drills. Drill software should serve mainly to debug and to help students retain their grasp of familiar concepts.
- » **Assign individually**—Most drills are designed to allow self-pacing and personalized feedback. Therefore, these activities usually work best for individual computer use. However, some teachers with limited technology resources have found other, ingenious ways to capitalize on the motivational and immediate feedback capabilities of drills. If all students in a class benefit from practice in a skill using a drill program, the teacher may divide them into small groups to compete with each

## TECHNOLOGY INTEGRATION EXAMPLE 1

### DRILL-AND-PRACTICE SOFTWARE

**TITLE:** Using Ratios

**CONTENT AREA/TOPIC:** Mathematics—Ratios and Proportions

**GRADE LEVELS:** 5–8

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Mathematics; Critical Thinking and Problem Solving: Solve problems

**DESCRIPTION:** The web-based activities at <http://math.rice.edu/~lanius/proportions/index.html> provide practice in recognizing ratios and proportions. After students learn these concepts in the classroom, the teacher prints out the on-screen pages, and students practice the concepts by completing the items. They write down their responses on the printout, then check their correctness by clicking an on-screen tab to reveal each correct answer. (Students can work together in pairs, discussing each of the items.) Teachers circulate to check student responses.

**Source:** Based on concepts from lessons in Cynthia Lanus’s Lessons Index at <http://math.rice.edu/~lanius/proportions/index.html>

other for the best group scores. The class could even be divided into two groups for a “relay race” competition to see which group can complete the assignment the fastest with the most correct answers.

- » **Use learning stations**—If not all students need the kind of practice that a drill provides, the teacher may make software one of several learning stations to serve students with identified weaknesses in one or more key skills. Drill-and-practice functions are used best when matched to the specific learning needs of individual students.

## TUTORIAL TEACHING FUNCTIONS

**Tutorial** software is an entire instructional sequence on a topic, similar to a teacher’s classroom instruction. This instruction usually is expected to be a self-contained instructional unit rather than a supplement to other instruction. Students should be able to learn the topic without any other help or materials. Unlike other types of instructional

software, tutorials are true teaching materials. Gagné et al. (1981) said that good tutorial software should address all nine instructional events.

People may confuse tutorial and drill activities for two reasons. First, drill software may provide elaborate feedback that reviewers may mistake for tutorial explanations. Even software developers may claim that a package is a tutorial when it is, in fact, a drill activity with detailed feedback. Second, a good tutorial should include one or more practice sequences to check students' comprehension. Since this kind of checking is a drill-and-practice function, teachers reviewing tutorial software can become confused about the primary purpose of the activity.

Tutorials often are categorized as linear or branching tutorials (Alessi & Trollip, 2001), as described below:

- » **Linear tutorial**—A simple, linear tutorial gives the same instructional sequence of explanation, practice, and feedback to all learners regardless of differences in their performance.
- » **Branching tutorial**—A more sophisticated, branching tutorial directs learners along alternate paths depending on how they respond to questions and whether they show mastery of certain parts of the material. Branching tutorials can range in complexity by the number of paths they allow and how fully they diagnose the kinds of instruction a student needs. More complex tutorials may also have computer-management capabilities; teachers can place each student at an appropriate level and get progress reports as each one goes through the instruction.

Tutorials are usually geared toward learners who can read fairly well and who are older students or adults. Since tutorial instruction is expected to stand alone, it is difficult to explain or give appropriate guidance on-screen to a non-reader. However, some tutorials aimed at younger learners have found clever ways to explain and demonstrate concepts with graphics, succinct phrases or sentences, or audio directions coupled with screen displays.

## Selecting Good Tutorial Software

Being a good teacher is a difficult assignment for any human, let alone a computer. However, software must accomplish this task to fulfill tutorial functions. In addition to meeting general criteria for good instructional software, well-designed tutorial programs should also meet the following standards:

- » **Extensive interactivity**—Good tutorials, like good teachers, should require students to give frequent and

thoughtful responses to questions and problems and should supply appropriate practice and feedback to guide students' learning. The most frequent criticism of tutorials is that they are "page-turners"—that is, they ask students to do very little other than read.

- » **Thorough user control**—User control refers to several aspects of a tutorial program. First, students should always be able to control the rate at which text appears on the screen. The program should not go on to the next information or activity screen until the user has pressed a key or has given some other indication of having completed the necessary reading. Next, the program should offer students the flexibility to review explanations, examples, or sequences of instruction or to move ahead to other instruction. The program should also provide frequent opportunities for students to exit the program if they like.
- » **Appropriate pedagogy**—The program's structure should provide a suggested or required sequence of instruction that builds on concepts and covers the content adequately. It should provide sufficient explanation and examples in both original and remedial sequences. In sum, it should compare favorably to an expert teacher's presentation sequence for the topic.
- » **Adequate answer-judging and feedback capabilities**—Whenever possible, programs should allow students to answer in natural language and should accept all correct answers and possible variations of correct answers. They should also give appropriate corrective feedback when needed, supplying this feedback after only one or two tries rather than frustrating students by making them keep trying indefinitely to answer something they may not know.
- » **Appropriate graphics**—Although some authors insist that graphics form part of tutorial instruction (Baek & Layne, 1988), others warn that graphics should be used sparingly and not interfere with the purpose of the instruction (Eiser, 1988). Where graphics are used, they should fulfill an instructional, aesthetic, or otherwise supportive function.
- » **Adequate recordkeeping**—Depending on the purpose of the tutorial, teachers may need to keep track of student progress. If the program keeps records on student work, teachers should be able to get progress summaries quickly and easily.

## Benefits of Tutorials

Since a tutorial includes drill-and-practice activities, helpful features include the same ones as for drills (immediate feedback to learners, motivation, and time savings) plus

the additional benefit of offering a self-contained, self-paced unit of instruction. Many successful uses of tutorials have been documented over the years. For examples, see Arnett (2000), Cann and Seale (1999), Ellington and Hardin (2008), Offner and Pohlman (2010), Steinberg and Oberem (2000), and Schwan and Riempp (2004).

While educational research does not address the specific benefits of tutorial instruction, Salden, Paas, and Merriënboer (2006) report research in aviation training using **intelligent tutoring systems**, a sophisticated kind of branching tutorial software that adapts the sequence of instruction to the needs of each learner. Salden et al. say that these kinds of systems personalize instruction and make the learning of complex tasks much more efficient by reducing cognitive load. While not common in education, intelligent tutors may be the future of this kind of software.

## Limitations and Problems Related to Tutorials

Tutorials can fulfill many much-needed instructional functions, but like drill and practice, they also attract their share of criticism, including:

- » **Criticism by constructivists**—Constructivists criticize tutorials because they deliver directed instruction rather than allowing students to generate their own knowledge through hands-on projects. Thus, they feel tutorials are trivial uses of the computer.
  - » **Lack of good products**—Software publishers describe fewer packages as tutorials than any other kind of microcomputer software. This is partly due to the difficulty and expense of designing and developing tutorial software. A well-designed tutorial sequence emerges from extensive research into how to teach the topic well. Designers must know what learning tasks the topic requires, the best sequence for students to follow, how best to explain and demonstrate essential concepts, common errors students are likely to make, and how to provide instruction and feedback to correct those errors. Therefore, programming and graphics can become fairly involved.
  - » **Reflect only one instructional approach**—Tutorial problems become still more difficult because teachers frequently disagree about what should be taught for a given topic, how to teach it most effectively, and in what order to present the learning tasks. For instance, a teacher may choose not to purchase a tutorial with a sound instructional sequence because it does not cover the topic the way he or she presents it. Not surprisingly, software companies tend to avoid programs that
- are difficult to develop and market. However, websites with tutorials are on the increase.
- Although tutorials have considerable value and are popular in military and industrial training, schools and colleges have never fully tapped their potential as teaching resources. However, recent trends toward combining tutorial software with audiovisual media and distance education initiatives may bring tutorial functions into more common use. See Figure 2 for examples of tutorial software and a summary of tutorial features.

## Using Tutorials in Teaching




Tutorial software can serve several classroom needs. This section describes integration strategies to meet each of these needs and offers guidelines and practical tips on how to integrate these strategies in the classroom.

### Classroom integration strategies for tutorial functions.

Self-instructional tutorials should in no way threaten teachers, since few conceivable situations make a computer preferable to an expert teacher. However, the tutorial's unique capability of presenting an entire interactive instructional sequence can assist in several classroom situations:

- » **Self-paced reviews of instruction**—Students often need to repeat instruction on a topic after the teacher's initial presentation. Some students may be slower to understand concepts and need to spend additional time on them. Others may learn better in a self-paced mode without the pressure to move at the same pace as the rest of the class. Still others may need a review before a test. Tutorials can provide self-paced instruction to address all these needs.
- » **Alternative learning strategies**—Some students, typically those at advanced levels, prefer to structure their own learning activities and proceed at their own pace. With a good tutorial, advanced students can use tutorials to glean a significant amount of background material prior to meeting with a teacher for assessment and/or further work assignments.
- » **Instruction when teachers are unavailable**—Some students have problems when they surge ahead of their class. The teacher cannot leave the rest of the class to provide the instruction that such an advanced student needs. It is also true that many schools, especially those in rural areas, may not offer certain courses because they cannot justify the expense of hiring a teacher for the comparatively few students who need physics, German, trigonometry, or other lower-demand courses.

**FIGURE 2 Tutorial Software Functions in Brief**

DESCRIPTION OF TUTORIAL SOFTWARE		
Characteristics	Criteria for Effective Tutorial Software	Benefits
<ul style="list-style-type: none"> <li>» Presents an entire instructional sequence</li> <li>» Is complete, rather than supplemental, instruction</li> <li>» Includes drill-and-practice functions</li> <li>» Can be either linear or branching</li> </ul>	<ul style="list-style-type: none"> <li>» Extensive interactivity</li> <li>» Thorough user control</li> <li>» Appropriate pedagogy</li> <li>» Adequate answer judging and feedback</li> <li>» Appropriate graphics</li> <li>» Adequate record keeping</li> </ul>	<ul style="list-style-type: none"> <li>» Same as drill and practice (immediate, private feedback, time savings)</li> <li>» Offers instruction that can stand on its own</li> </ul>
SAMPLE SOFTWARE WITH TUTORIAL FUNCTIONS		
<p><b>Trigonometry Challenge by ETCAL</b></p> <p>Instruction in trigonometry concepts: Sequence of screens gives information on concepts such as the Pythagorean Theorem, followed by practice items with feedback</p> <p><a href="http://www.etcail.com/page10.html">http://www.etcail.com/page10.html</a></p> 	<p><b>Laws of Motion by The Physics Classroom</b></p> <p>Instruction in physics concepts: Sequence of screens gives information and animated demonstrations to teach concepts such as Newton's Laws of Motion, followed by practice items</p> <p><a href="http://www.physicsclassroom.com/Class/newlaws">http://www.physicsclassroom.com/Class/newlaws</a></p> 	<p><b>The Constitution by Congress for Kids</b></p> <p>Instruction in aspects of U.S. government: Sequence of screens gives explanation of how the government works, with assessment items to review concepts and check comprehension</p> <p><a href="http://congressforkids.net/Constitution_writingconstitution.htm">http://congressforkids.net/Constitution_writingconstitution.htm</a></p> 

Source: A special thanks to the Dirksen Congressional Center for permission to use information and screenshots from Congress for Kids (<http://www.congressforkids.net>). Images reprinted by permission of ETCAL Products, The Physics Classroom, and the Dirksen Congressional Center.

Well-designed tutorial courses, especially in combination with other methods such as distance learning, can help meet these students' needs.

**Guidelines for using tutorials.** Use the following guidelines to make the best use of tutorial capabilities when designing integration strategies for tutorial functions:

- » **Assign individually**—Like drill-and-practice functions, tutorial functions are designed for use by individuals rather than by groups of students.
- » **Use learning stations or individual checkout**—Depending on which of the above strategies it promotes, a tutorial may be used in a classroom learning station or may be available for checkout at any time in

## TECHNOLOGY INTEGRATION EXAMPLE 2

### TUTORIAL SOFTWARE

**TITLE:** Minds on Physics

**CONTENT AREA/TOPIC:** Physics—Newton's Laws of Motion

**GRADE LEVELS:** 9–12

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Science; Critical Thinking and Problem Solving—Use systems thinking, solve problems; Communication and Collaboration—Communicate clearly

**DESCRIPTION:** After presenting the topic in the classroom using usual instructional strategies, the teacher assigns the Minds on Physics (MOP) module (<http://www.physicsclassroom.com>) as a mastery learning activity. Students complete the assigned online materials as homework (or classwork) and submit their encrypted “success codes” to their teacher. The teacher then checks that students have completed them successfully by using a Decryption page provided on the site. The teacher then assigns one or more of the online labs to illustrate application of Newton's Laws, and uses the scoring rubric provided to assess students' write-up(s) of their results.

**Source:** Based on The Physics Classroom materials developed by Tom Henderson at <http://www.physicsclassroom.com/mop/join.cfm>

a library/media center. Sometimes teachers send students to learning stations with tutorials in order to review previously presented material while the teacher works with other students. (See Technology Integration Example 2.)

## SIMULATION TEACHING FUNCTIONS

A **simulation** is a computerized model of a real or imagined system that is designed to teach how the system works. Unlike tutorial and drill-and-practice activities, in which the teaching structure is built into the package, learners using simulations usually must choose tasks to do and the order in which to do them. Alessi and Trollip (2001) identify two main types of simulations: those that teach about something and those that teach how to do something; they also divide the “how to” simulations into procedural and situational types.

## Simulations That Teach About Something

Alessi and Trollip (2001) further divide “simulations that teach about something” into two other categories: physical simulations and iterative simulations. These sub-categories are based on how users interact with them.

**Physical simulations.** These simulations allow users to manipulate things or processes represented on the screen. For example, students might see selections of chemicals with instructions on how to combine them to see the result, or they might see how various electrical circuits operate. More recent investigations of simulation software include the use of three-dimensional models (e.g., Kim, 2006).

**Iterative simulations.** These simulations speed up or slow down processes that usually happen either so slowly or so quickly that students cannot see the events unfold. For example, software may show the effects of changes in demographic variables on population growth, or the effects of environmental factors on ecosystems. Alessi and Trollip (2001) refer to this type as “iterative” because students can run it over and over again with different values, observing the results each time. Biological simulations, such as those on genetics, are popular since they help students experiment with natural processes. Genetics simulations let students pair animals with given characteristics and see the resulting offspring.

## Simulations That Teach How to Do Something

Alessi and Trollip (2001) divide the “how to” simulations into procedural and situational types. Again, these categories are based on how users are able to interact with them.

**Procedural simulations.** These activities teach the appropriate sequences of steps to perform certain procedures. They include diagnostic programs, in which students try to identify the sources of medical or mechanical problems, and flight simulators, in which students simulate piloting an airplane or other vehicle.

**Situational simulations.** These programs give students hypothetical problem situations and ask them to react. Some simulations allow for various successful strategies, such as letting students play the stock market or operate businesses. Others have most desirable and least desirable options, such as choices when encountering a potentially volatile classroom situation.

The descriptions above serve to clarify the various forms a simulation might take, but teachers need not feel they should be able to classify a given simulation into one of these categories. Simulations usually emphasize

learning about the system itself rather than learning general problem-solving strategies. For example, a program called *The Factory* has students build products by selecting machines and placing them in the correct sequence. Since the program emphasizes solving problems in correct sequence rather than manufacturing in factories, it should probably be called a problem-solving activity rather than a simulation. Programs such as *City Creator* (<http://www.citycreator.com>), which let students design their own cities, provide more accurate examples of building-type simulations.

## Selecting Good Simulation Software

Simulations vary so much in type and purpose that a uniform set of criteria is not possible. For some simulations, a realistic and accurate representation of a system is essential, but for others, it is important only to know what the screen elements represent. Since the screen often presents no set sequence of steps, simulations need good accompanying documentation—more than most software. A set of clear directions helps the teacher learn how to use the program and show the students how to use it rapidly and easily. See Figure 3 for examples of simulation software and a summary of simulation features.

## Benefits of Simulations

The field of science seems to include more simulations than any other area (Andaloro, 1991; Eskrootchi & Oskrochi, 2010; Evagoroua, Nicolaoub, & Constantinoub, 2010; Jaakkola & Nurmi, 2008; Lalley, Piotrowski, Battaglia, Brophy, & Chugh, 2010; Lunce & Bailey, 2007; Richards, 1992; Ronen, 1992; Urban-Woldron, 2009), but the use of simulations has also proven popular in teaching social science topics (Adams, 1998; Allen, 1993; Clinton, 1991; Estes, 1994; Iannou, Brown, Hannafin, & Boyer, 2009). However, simulations are currently available in other content areas, and many are now able to be accessed online. Some updated products combine the control, safety, and interactive features of computer simulations with the visual impact of pictures of real-life devices and processes. (For example, see the *Digital Frog* simulation at <http://www.digitalfrog.com>.)

Research comparing simulations to “real” activities often qualify the benefits they report by saying that the impact of simulations depend on how and with whom they are used. For example, in a study of a simulation of environmental concepts, Eskrootchi and Oskrochi (2010) report that, “Simulations do not work on their own; there needs to be some structuring of the students’ interactions with the

simulation to increase effectiveness” (p. 236). Gelbart, Brill, and Yarden (2009) found that some students learn more than others from simulations designed to teach genetics concepts. Research on teaching “systems thinking” skills to elementary school students by using environmental simulations (Evagoroua, Nicolaoub, & Constantinoub, 2010) reported good impact on some skills but not others. One common finding is that simulations work best when combined with nonsimulation activities. Urban-Woldron (2009) found that physics simulations were most useful as a follow-up to hands-on activities, and Jaakkola and Nurmi (2008) reported that simulations in electrical concepts had more positive benefits with elementary school children when accompanied by hands-on learning.

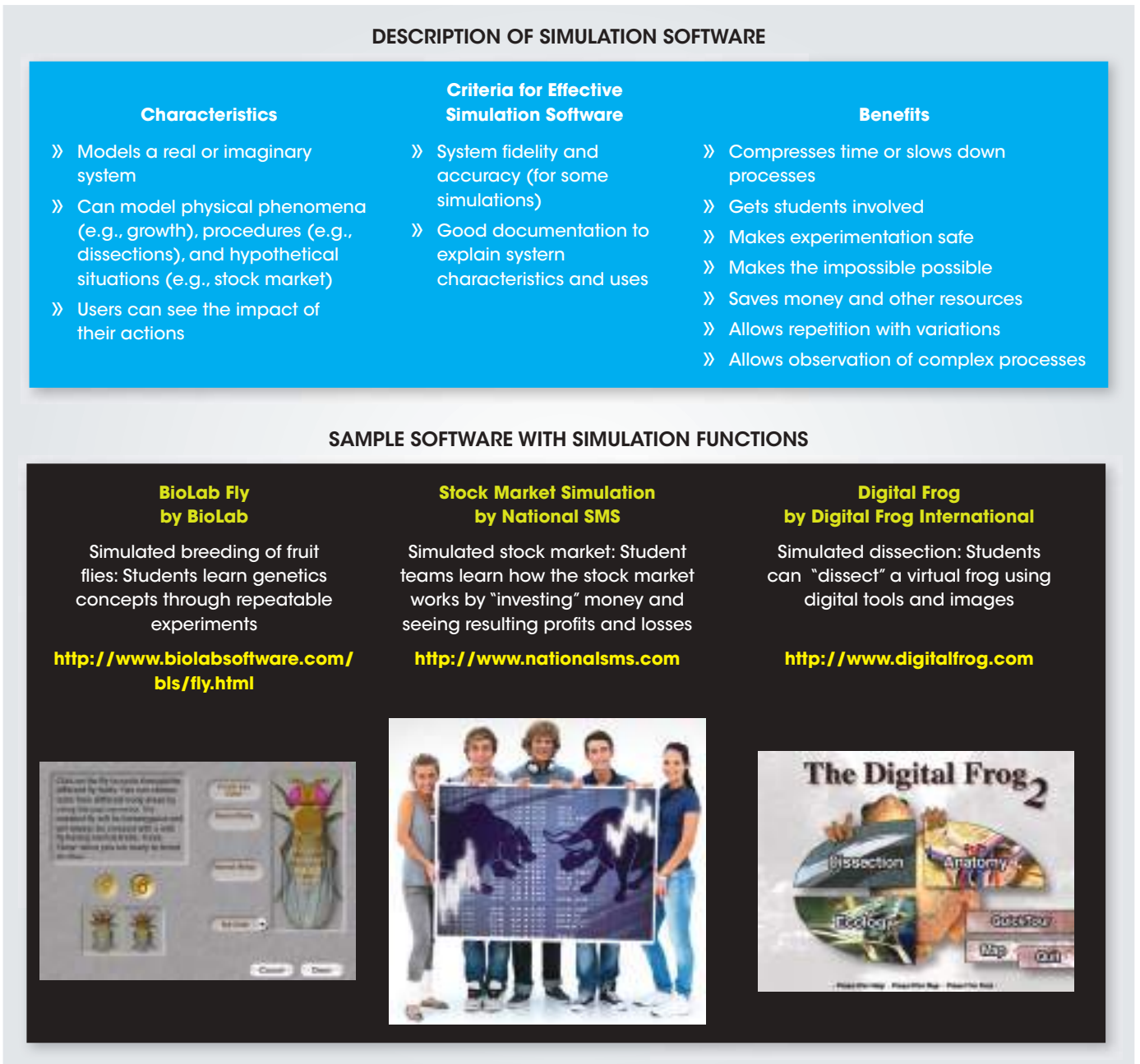
However, other studies report unqualified positive results from simulations. Lalley et al. (2010) compared the effectiveness of simulated and physical frog dissections on learning, retention, and student satisfaction and found no significant differences on any measure. They concluded that the simulated dissection “provides a viable alternative to physical dissection . . . and may be appealing to teachers and students for a number of practical and/or ethical reasons” (p. 189). Iannou et al. (2009) reported that a problem-based simulation designed to teach world issues made students more motivated to learn social studies than did text-based materials.

Wieman and Perkins (2005) report research that indicates interactive simulations in physics are frequently much more effective than seeing actual demonstrations. They believe that real-life demonstrations and labs include peripheral information that is not central to the concept being learned. While an expert can easily filter out the “extra” information to focus on the phenomenon of interest, a novice does not even know what to filter out. Thus, the extra information produces confusion and much higher cognitive loads for novice learners.



Simulation software can be used instead of or as a supplement to science activities such as dissections.  
Photo by W. Wiencke.

**FIGURE 3** Simulation Software Functions in Brief



Source: BioLab Fly copyright 2011 by Bob Doltar, All Rights Reserved. Stock Market Simulation courtesy of StockTrak, Inc., www.stocktrack.com and www.nationalsms.com. The Digital Frog reprinted by permission.

Depending on the topic and the way it is used, a simulation has potential to provide one or more of the following instructional benefits (Alessi & Trollip, 2001):

**Compress time.** This feature is important whenever students study the growth or development of living things (e.g., pairing animals to observe the characteristics of their offspring) or other processes that take a long time (e.g., the movement of a glacier). A simulation can make something happen in seconds that normally takes days, months, or longer, so that students can cover more variations of the activity in a shorter time.

**Slow down processes.** Conversely, a simulation can also model processes normally invisible to the human eye because they happen so quickly. For example, physical education students can study the slowed-down movement of muscles and limbs as a simulated athlete throws a ball or swings a golf club.

**Get students involved.** Simulations can capture students' attention by placing them in charge of things and asking, "What would you do?" The results of their choices can be immediate and graphic. Users can also interact with the program instead of just seeing its output.

**Make experimentation safe.** Whenever learning involves physical danger, simulations are the strategy of choice. This is true when students are learning to drive vehicles, handle volatile substances, or react to potentially dangerous situations. They can experiment with strategies in simulated environments that might result in personal injury to themselves or others in real life. For example, the First Responders Simulation and Training Environment (FiRSTE) allows for the training of civilian first responders to respond to attacks employing weapons of mass destruction (Tichon, Hall, Hilgers, Leu, & Agarwal, 2003).

**Make the impossible possible.** Very often, teachers simply cannot give students access to the resources or situations that simulations can. Simulations can show students, for example, what it would be like to walk on the moon or how to react to emergencies in a nuclear power plant. They can see cells mutating or hold countrywide elections. They can even design new societies or planets and see the results of their choices. For example, one researcher at The University of California–Davis (Virtual schizophrenia in Second Life, 2007) re-created a mental health treatment ward in a virtual world and gave each of his students a taste of what it means to experience schizophrenia in the real world. As students' virtual characters walked the hallways, they were overcome by hallucinations, including “the floor disappearing from underfoot, writing on posters that morphs into derogatory words, a pulsating gun that suddenly appears on a table, and menacing voices that laugh.”

**Save money and other resources.** Many school systems are finding dissections of animals on a computer screen to be much less expensive and just as instructional as using real frogs or cats. (It is also easier on the animals!) Depending on the subject, a simulated experiment may be just as effective a learning experience as an actual experiment is, but at a fraction of the cost.

**Allow repetition with variations.** Unlike in real life, simulations let students repeat events as many times as they wish and with unlimited variations. They can pair any number of cats or make endless spaceship landings in a variety of conditions to compare the results of each set of choices.

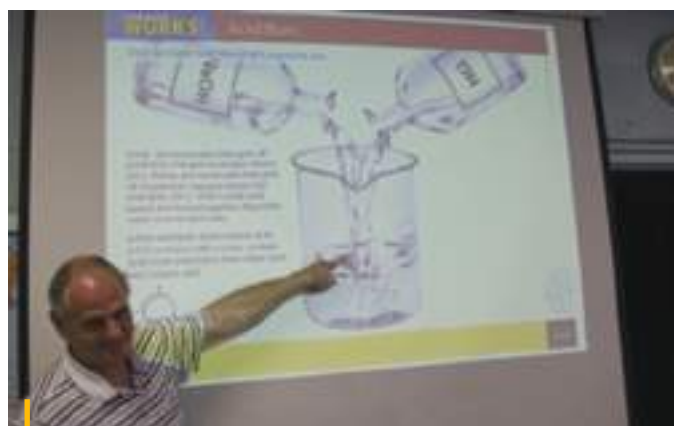
**Allow observation of complex processes.** Real-life events often are so complex that they are confusing—especially to those seeing them for the first time. When many things happen at once, students find it difficult to focus on the operation of individual components. Who could understand the operation of a stock market by looking at the real thing without some introduction? Simulations can isolate parts of activities and control background noise. This makes it easier for students to see what is happening when, later, all the parts come together in the actual activity.

## Limitations and Problems Related to Simulations

Most educators acknowledge the instructional usefulness of simulations (Prensky, 2007). There are some concerns, however, including the following:

**Criticism of virtual lab software.** Though modern simulation software makes it possible to do simulated labs for topics in biology and chemistry, both the American Chemical Society (2008) and the National Science Teachers Association (Davis, 2009; NSTA, 2007) have come out strongly against replacing hands-on, in-class labs with virtual ones, saying that simulations should be used only as supplements to regular labs. The College Board has also indicated that students may not get Advanced Placement (AP) course credit for any courses that substitute virtual labs for hands-on labs.

**Accuracy of models.** Prensky (2007) acknowledges that simulations are in limited use in schools and feels this is because there is a shortage of products that are of high enough quality to be useful for school learning. Teachers know that when students see simplified versions of systems in a controlled situation, they may get inaccurate or imprecise perspectives on the systems' complexity. For example, students may feel they know all about how to react to driving situations because they have experienced simulated versions of them. Many educators feel strongly that situational simulations must be followed at some point by real experiences, a position with which organizations such as the NSTA and the American Chemical Society concur. In addition, many teachers of very young children feel that learners at early stages of their cognitive development should experience things first with their five senses rather than on computer screens.



Though modern simulation software makes it possible to do simulated labs in biology and chemistry, both the American Chemical Society and the National Science Teachers Association say that simulations should be used only as supplements to regular labs. Photo by W. Wiencke.



**Misuse of simulations.** Sometimes, simulations are used to teach concepts that could just as easily be demonstrated on paper, with manipulatives, or with real objects. If students can master the activities of a simulation without actually developing effective problem-solving skills, such applications can actually encourage counterproductive behaviors.

## How to Use Simulations in Teaching: Integration Strategies and Guidelines

Simulations are considered among the most potentially powerful computer software resources; as with most software, however, their usefulness depends largely on the program's purpose and how well it fits in with the purpose of the lesson and student needs. Teachers are responsible for recognizing the unique instructional value of each simulation and using it to its best advantage. For example, Lee and Guo (2008) offer teacher guidelines for using simulations in physics instruction to achieve the most impact.

**Classroom applications of simulation functions.** Real systems are usually preferable to simulations, but a simulation is useful when the real situation is too time consuming, dangerous, expensive, or unrealistic for a classroom presentation. Simulations should be considered in the following situations:

- » **In place of or as supplements to lab experiments**—When adequate lab materials are not available, teachers should try to locate computer simulations of the required experiments. Many teachers find that simulations offer effective supplements to real labs, either to prepare students for making good use of the actual labs or as follow-ups with variations of the original experiments without using consumable materials. Some simulations actually allow users to perform experiments that they could not otherwise manage or that would be too dangerous for students.
- » **In place of or as supplements to role-playing**—Many students either refuse to role play in front of a class or get too enthusiastic and disrupt the classroom. Computerized simulations can take the personal embarrassment and logistical problems out of the learning experience, make classroom role playing more controllable, and spark students' imagination and interest in the activities.
- » **In place of or as supplements to field trips**—Seeing an activity in its real setting can be a valuable experience, especially for young children. Sometimes, however, desired locations are not within reach of the school, and a simulated experience of all or part of the process is the next best thing. As with labs, simulations provide good introductions or follow-ups to field trips.

- » **Introducing and/or clarifying a new topic**—Software that allows students to explore the elements of an environment in a hands-on manner frequently provides students' first in-depth contact with a topic. This seems to accomplish several purposes. First, it is a non-threatening way to introduce new terms and unfamiliar settings. Students know they are not being graded, so they feel less pressure than usual to learn everything right away. A simulation can be simply a get-acquainted look at a topic; it can also build students' initial interest in a topic. Highly graphic, hands-on activities draw them in and whet their appetite to learn more. Finally, some software helps students see how certain prerequisite skills relate to the topic; this may motivate students more strongly to learn the skills than if the skills were introduced in isolation from the problems to which they apply. For example, simulations such as *Crisis at Fort Sumter* (<http://www.tulane.edu/~sumter>) helps students see the impact of events leading up to the U.S. Civil War.
- » **Fostering exploration and process learning**—If simulations are used in systematic ways that emulate in-class science labs, they can illustrate and provide practice in using scientific methods.
- » **Encouraging cooperation and group work**—Sometimes a simulated demonstration can capture students' attention quickly and effectively and interest them in working together on a product. For example, a simulation on immigration or colonization might be the "grabber" a teacher needs to launch a group project in a social studies unit.

**Guidelines for using simulation functions.** Simulations offer more versatile implementation than tutorials or drills do. They usually work equally effectively with a whole class, small groups, or individuals. A teacher may choose to introduce a lesson to the class by displaying a simulation or to divide the class into small groups and let each of them solve problems. Because they instigate discussion and collaborative work so well, simulations usually are considered more appropriate for pairs and small groups than for individuals. However, individual use certainly is not precluded. (See Technology Integration Example 3.)

## INSTRUCTIONAL GAME TEACHING FUNCTIONS

Technology-based games bridge the worlds of gaming, entertainment, and education in an attempt to deliver fun and effective learning. Simply defined, **instructional games** add game-like rules and/or competition to learning activities. Even though teachers often use them in the same way as they do drill-and-practice or simulation software, games usually

## TECHNOLOGY INTEGRATION EXAMPLE 3

### SIMULATION SOFTWARE

**TITLE:** Crisis at Fort Sumter

**CONTENT AREA/TOPIC:** U.S. History—Civil War period

**GRADE LEVELS:** 10–12

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subject: History; Creativity and Innovation—Think creatively; Critical Thinking and Problem Solving—Reason effectively, make judgments and decisions, solve problems; Communication and Collaboration—Communicate clearly

**DESCRIPTION:** Introduce students to the historical simulation website Crisis at Fort Sumter (<http://www.tulane.edu/~sumter>). The simulation outlines the decisions that President Abraham Lincoln had to make concerning Fort Sumter. Tell them to choose one decision on which they disagree with the President, outline what they would have done differently, and write a description defending their alternative solution. They post the description on the discussion board, and the class discusses the merits of the various proposals and the impact each might have made on the situation.

**Source:** Based on concepts from an exercise idea submitted at the MERLOT website: <http://www.merlot.org/merlot/viewAssignment.htm?id=355336&backPage=%2Fassignments.htm%3Fmaterial%3D79032&hitlistPage=%2Fassignments.htm%3Fmaterial%3D79032>

are listed as a separate software activity because their instructional connotation to students is slightly different. When students know they will be playing a game, they expect a fun and entertaining activity because of the challenge of the competition and the potential for winning (Gee, 2004; Gros, 2007; Raessens & Goldstein, 2005; Randel, Morris, Wetzell, & Whitehill, 1992; Squire, 2005). Teachers frequently intersperse games with other activities to hold students' attention or as a reward for accomplishing other activities, even though games, by themselves, can be powerful teaching tools.

It is important to recognize the common characteristics that set instructional games apart from other types of software: game rules, elements of competition or challenge, and amusing or entertaining formats. These elements generate a set of mental and emotional expectations in students



Instructional game software uses students' natural love of games to lure them into learning.

© Shutterstock

that make game-based instructional activities different from nongame ones.

## Selecting Good Instructional Games

Since instructional games often amount to drills or simulations overlaid with game rules, these three types of software often share many of the same criteria (e.g., better reinforcement for correct answers than for incorrect ones). Hong, Cheng, Hwang, Lee, and Chang (2009) surveyed educators to create a checklist of criteria that determine the educational value of a game. The seven categories they identified included: mentality challenge, emotional fulfillment, knowledge enhancement, thinking skill development, interpersonal skills, spatial ability development, and bodily coordination. Teachers can use the following criteria to choose effective instructional games:

**Appealing formats and activities.** When Malone (1980) examined the evidence on what makes things fun to learn, he found that the most popular games included elements of adventure and uncertainty, and levels of complexity matched to learners' abilities.

**Instructional value.** Teachers should examine instructional games carefully for their value as both educational and motivational tools. While a number of researchers argue for the benefits of educational games (e.g., Gee, 2004; Squire, 2005), others question their value (e.g., Clark, 2007).

**Physical dexterity is reasonable.** Teachers should ensure that students will be motivated rather than frustrated by the activities. Unless the object of the game is to learn physical dexterity (e.g., for students with physical challenges), the focus of the game should be learning content-area skills, rather

than physical dexterity. For content-area games, the level of physical dexterity should be manageable by all students.

**Social, societal, and cultural considerations.** Games may be inappropriate for children if they are not designed with a respectful outlook. For instance, games that call for violence or combat require careful screening, not only to avoid students' modeling this behavior, but also because girls often perceive the attraction of these activities differently than boys do. In addition, games may present females and various ethnic and cultural groups in stereotypical roles. Ideally, teachers should choose games that do not perpetuate stereotypes, while at the same time highlighting positive messages (e.g., peace and friendship) rather than unnecessary violence (e.g., aggression).

## Benefits of Instructional Games

A classroom without elements of games and fun would be a dry, barren landscape for students to traverse. In an early review of the effectiveness of games for educational purposes, Randel et al. (1992) found “[the fact] that games are more interesting than traditional instruction is both a basis for using them as well as a consistent finding” (p. 270). They also observed that retention over time favors the use of simulations/games. Successful uses of games have been reported in many content areas (Annetta, Mangrum, Holmes, Collazob, & Chenga, 2009; Flowers, 1993; Muckerheide, Mogill, & Mogill, 1999; Trotter, 1991).




The appeal of games seems to center around students' desire to compete and play. Games provide teachers with

**FIGURE 4** Instructional Game Software Functions in Brief

**DESCRIPTION OF INSTRUCTIONAL GAME SOFTWARE**

Characteristics	Criteria for Effective Instructional Game Software	Benefits
<ul style="list-style-type: none"> <li>» Gives opportunities for content skill practice or problem solving in a fun, entertaining environment</li> <li>» Has game rules</li> <li>» Challenges students to compete and win</li> </ul>	<ul style="list-style-type: none"> <li>» Appealing formats and activities</li> <li>» Obvious instructional, as opposed to entertainment value</li> <li>» Reasonable required levels of physical dexterity</li> <li>» Minimal violence/aggression</li> </ul>	<ul style="list-style-type: none"> <li>» Fun activities motivate students to spend more time on the topic</li> </ul>

**SAMPLE SOFTWARE WITH INSTRUCTIONAL GAME FUNCTIONS**

<p style="text-align: center;"><b>Spore</b> by Electronic Arts, Inc.</p> <p>Game to apply evolution concepts: Students evolve a creature through five evolutionary stages</p> <p style="text-align: center;"><a href="http://www.spore.com" style="color: yellow;">http://www.spore.com</a></p> 	<p style="text-align: center;"><b>Lure of the Labyrinth</b> by Thinkport</p> <p>Game to apply pre-algebra skills: Students use math skills to locate a missing pet in the labyrinth</p> <p style="text-align: center;"><a href="http://www.labyrinth.thinkport.org" style="color: yellow;">http://www.labyrinth.thinkport.org</a></p> 	<p style="text-align: center;"><b>Jeopardy Review Generator</b> by Super Teacher Tools</p> <p>Game to practice any content area skills: Teachers generate content review items for a Jeopardy game</p> <p style="text-align: center;"><a href="http://www.superteachertools.com/jeopardy" style="color: yellow;">http://www.superteachertools.com/jeopardy</a></p> 
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Source: SPORÉ™ image used with permission of Electronic Arts Inc. Lure of the Labyrinth used by permission of Maryland Public Television. Jeopardy Review Generator reprinted by permission of www.superteachertools.com, courtesy of Jason Kries.

## SHOULD STUDENTS PLAY (SOFTWARE) GAMES IN SCHOOL?

*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.*

Some schools, such as those with a college preparatory focus, do not allow the use of instructional games of any kind, even software with a practice or simulation purpose. Meanwhile,

some game proponents are saying that education should be using more games to tap into students' natural love of these formats. Is there a compelling case to be made for allowing the use of instructional game software to achieve specific educational goals? That is, can games do something in an instructional situation that no other strategy is able to do? If so, what? For background reading, see Henry Jenkins' article for PBS (<http://www.pbs.org/kcts/videogame/revolution/impact/myths.html>), Mark Bauerlein's (2010) blog post for the Chronicle of Higher Education (<http://chronicle.com/blogs/brainstorm/video-game-researchacademic-achievement/22105>), and Kim and Chang's (2010) article ([http://www.ifets.info/journals/13\\_3/20.pdf](http://www.ifets.info/journals/13_3/20.pdf)).

opportunities for taking advantage of this innate desire to get students to focus on a curriculum topic. Some educators and observers feel strongly that video games hold special promises for improving classroom teaching strategies and making learning more engaging and motivational (Ash, 2011; Corbett, 2010; Squire, 2005). See Figure 4 for examples of instructional game software and a summary of game features.

### Limitations and Problems Related to Instructional Games

Some teachers believe that any time they can sneak in learning under the guise of a game, it is altogether a good thing. However, games are also frequently criticized from several standpoints:

**Learning versus having fun.** Some schools forbid any use of games because they believe games convince students that they are escaping from learning, thus drawing attention away from the intrinsic value and motivation of learning. Critics also feel that winning the game becomes a student's primary focus and that the instructional purpose is lost in the pursuit of this goal. Observers disagree about whether getting lost in the game is a benefit

or a problem. See the Hot Topic Debate, which addresses this issue.

**Confusion of game rules and real-life rules.** Some teachers have observed that students can become confused about which part of the activity is the game and which part is the skill; they may then have difficulty transferring their skill to later nongame situations. For example, the teacher's manual for Sunburst's How the West Was One + Three × Four game reminds teachers that some students can confuse the math operations rules with the game rules and that teachers must help them recognize the need to focus on math rules and use them outside the game.

**Inefficient learning.** Although students obviously find many computer games exciting and stimulating, it is sometimes difficult to pinpoint their educational value. Teachers must try to balance the motivation that instructional games bring to learning against the classroom time they take away from nongame strategies. For example, students may become immersed in the challenge of the Spore game series (<http://www.spore.com>), but more efficient ways to teach evolution concepts may be just as motivating.

**Classroom barriers.** In a review of research on video games for instruction, Rice (2007) found six barriers to

widespread classroom implementation. These included negative teacher perceptions toward video games, as well as a lack of several characteristics required to make best use of these materials: state of the art graphics, adequate computing hardware required to run advanced video games, short class periods that hindered long-term engagement in complex games, real-world affordances, and alignment to state standards.

## Using Instructional Games in Teaching

Instructional games can serve several classroom needs. This section describes integration strategies to meet each of these needs and offers guidelines and practical tips on how to integrate these strategies in the classroom.

### Classroom applications for instructional games.

Several kinds of instructional opportunities invite teachers to take advantage of the motivational qualities of games. Instructional games should be considered in the following situations:

- » **In place of worksheets and exercises**—As with drill-and-practice software, teachers can use games to help students acquire automatic recall of prerequisite skills.
- » **To teach cooperative group working skills**—Like simulations, many instructional games serve as the basis for or introduction to group work. In addition, some games can be played collaboratively over the Internet (e.g., via an Internet-enabled game console). A game's competitive qualities can present opportunities for competition among groups.
- » **As a reward**—Perhaps the most common use of games is to reward good work. This may be a valid role for instructional software, but teachers should avoid overuse, as the game can lose its motivational value and become an “electronic babysitter.” In addition, using games as rewards disregards the power of games to be teachable software, limiting them to a behaviorist tool. Some schools actually bar games from classrooms for fear that they overemphasize the need for students to be entertained.

**Guidelines for using instructional games.** Recent studies seem to indicate that instructional games can be useful in fostering higher order skills but that their usefulness hinges on how teachers employ them (DiPietro, Ferdig, Boyer, & Black, 2007; Henderson, Klemes, & Eshet, 2000; Houssart & Sams, 2008; Rieber, Smith, & Noah, 1998). Use the following guidelines to make the best use of game

capabilities when designing integration strategies for game functions:

- » **Use sparingly.**—Some educators believe that games—especially computer-based ones—are overused, misused, and used inappropriately. Use games sparingly so that students effectively learn from them and continue to stay motivated by the game play.
- » **Involve all students.**—Make sure that girls and boys alike are participating and that all students have a meaningful role.
- » **Emphasize the content-area skills first.**—Before students begin playing, make sure they know the relationship between game rules and content-area (e.g., math) rules. Students should recognize which rules they will be using in their later work and which are merely part of the game environment. (See Technology Integration Example 4.)

## TECHNOLOGY INTEGRATION EXAMPLE 4

### INSTRUCTIONAL GAME SOFTWARE

**TITLE:** Do I Have a Right?

**CONTENT AREA/TOPIC:** Civics—The Bill of Rights

**GRADE LEVELS:** 8–10

**NETS FOR STUDENTS:** Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subject: Government and Civics; Critical Thinking and Problem Solving—Make judgments and decisions

**DESCRIPTION:** Using a packet of materials on the Bill of Rights, the teacher reads a scenario in which the world has been destroyed and a “Pamphlet of Protections” must be created to define the rights people will have. Students identify their “top ten” rights from a checklist and the teacher polls the class to see which were selected. The teacher compares this task to the challenge that framers of the Constitution faced and reviews each of the Bill of Rights they created. After review and discussion, students apply what they learned with “Do I Have a Right?” online game software. They become lawyers who must decide whether potential clients “have a right.” The more clients they serve, the more cases they win, and the faster the law firm grows.

**Source:** Based on ideas from lesson plan at the iCivics website: <http://www.icivics.org/teachers/lesson-plans/bill-rights-you-mean-ive-got-rights>

## PROBLEM-SOLVING TEACHING FUNCTIONS

Although simulations and instructional games are often used to help teach problem-solving skills, **problem-solving software** is designed especially for this purpose. **Problem-solving** software functions may focus on fostering component skills in or approaches to general problem-solving ability, or provide opportunities to practice solving various kinds of content-area problems. According to Mayes (1992), problem solving is cognitive processing directed at achieving a goal when the solution is not obvious. One way to think about problem solving is through three of its most important components: recognition of a goal (an opportunity for solving a problem), a process (a sequence of physical activities or operations), and mental activity (cognitive operations to pursue a solution).

Though most problem-solving literature focuses on skills in solving mathematical problems, research on problem solving covers a wide variety of desired component behaviors. The literature mentions such varied subskills for problem solving as metacognition, observing, recalling information, sequencing, analyzing, finding and organizing information, inferring, predicting outcomes, making analogies, and formulating ideas. Although there are many opinions about the proper role of instructional software in fostering these abilities, there seem to be two main approaches:

- » **Content-area problem-solving skills**—Some problem-solving software focuses on teaching content-area skills, primarily in mathematics and science. For example, the Geometric Supposer (<http://www.cet.ac.il/math-international/software5.htm>) encourages students to learn strategies for solving geometry problems by drawing and manipulating geometric figures. Others, like Alien Rescue developed by the University of Texas (<http://www.edb.utexas.edu/alienrescue>), are what might be called problem-solving “environments.” These complex, multifaceted packages offer a variety of tools that allow students to create solutions to science-related problems presented by a scenario. Still others provide opportunities to practice solving specific kinds of math or science problems.
- » **Content-free problem-solving skills**—Some educators feel that general problem-solving ability can be taught directly by specific instruction and practice in its component strategies and subskills (e.g., recalling facts, breaking a problem into a sequence of steps, or predicting outcomes). Others suggest placing students in problem-solving environments and, with some

coaching and guidance, letting them develop their own heuristics for attacking and solving problems.

Although the purposes of the two views overlap somewhat, the first is directed more toward motivating students to attack problems and to recognize problem solving as an integral part of everyday life, while the second aims to help students practice prerequisite skills for specific kinds of problem solving.

### Selecting Good Problem-Solving Software

Qualities to look for in good problem-solving software depend on the purpose of the software. In general, problem formats should be interesting and challenging, and software should have a clear link to developing a specific problem-solving ability. Software documentation should state clearly which specific problem-solving skills students will learn and how the software fosters them. See Figure 5 for examples of problem-solving software and a summary of problem-solving features.

### Benefits of Problem-Solving Software


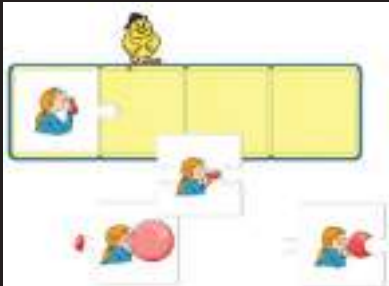

Research and practice indicates that problem-solving software can help students in at least three different ways:

**Promotes visualization in mathematics problem solving.** Research results in mathematical problem-solving skills tend to support the hypothesis that software, such as *Geometer's Sketchpad* and other software that rely on graphical displays, helps students in various ways to visualize abstract concepts and, thus, better understand how to solve problems that call for those concepts. For example, Abramovich and Ehrlich (2007) found that use of graphing software “makes it possible to capitalize on the power of mathematical visualization in reducing inequality to equation(s)” (p. 193). Todd and Wiechmann (2008) found that combining computer algebra systems (CAS) software with symbolic geometry system software facilitates the work involved in complex problems, helping to “raise the students above (the) noise level, allowing them to see the problem as a whole” (p. 56). Kaplan and Wu (2006) also found that both static and animated graphics helped students better understand and solve probability problems. Bos (2007) reported that interactive software used with graphing calculators helps students solve problems with quadratic equations more than did learning environments without these tools. Finally, although Santos-Trigo and Cristobal-Escalante (2008) were among

**FIGURE 5 Problem Solving Software Functions in Brief**

DESCRIPTION OF PROBLEM-SOLVING SOFTWARE		
Characteristics	Criteria for Effective Problem-Solving Software	Benefits
<p>Four different types:</p> <ol style="list-style-type: none"> <li>1. Tools to help students solve problems</li> <li>2. Environments that challenge students to create solutions to complex problems</li> <li>3. Problems to help develop component problem-solving skills (e.g., recalling facts, following a sequence)</li> <li>4. Opportunities for practice in solving content-area problems</li> </ol>	<ul style="list-style-type: none"> <li>» Challenging, interesting formats</li> <li>» Clear links to developing specific problem-solving skills or abilities</li> </ul>	<ul style="list-style-type: none"> <li>» Challenging activities motivate students to spend more time on the topic</li> <li>» Prevents inert knowledge by illustrating situations in which skills apply</li> </ul>

SAMPLE SOFTWARE WITH PROBLEM SOLVING FUNCTIONS		
<p><b>Memory Challenge</b> by The Critical Thinking Co.</p> <p>Practice exercises to improve visual memory skills required for reading and math activities</p> <p><a href="http://www.criticalthinking.com">http://www.criticalthinking.com</a></p> 	<p><b>Sequences</b> by The Tool Factory, Inc.</p> <p>Text-free practice in teaching sequencing by ordering events in a correct sequence</p> <p><a href="http://www.toolfactory.com">http://www.toolfactory.com</a></p> 	<p><b>Crazy Machines</b> by Viva Media LLC</p> <p>Teaches how to recognize math situations in word problems and use graphic organizers to understand and plan solutions</p> <p><a href="http://www.viva-media.com">http://www.viva-media.com</a></p> 

Source: Memory Challenge reprinted by permission of the Critical Thinking Co. Sequences is a Sherston Software product, www.sherstonamerica.com, reprinted by permission. Crazy Machines 2: The Wacky Contraptions Game © FAKT published by Viva Media, reprinted by permission.

those who reported that dynamic geometry systems software facilitated students solving geometry problems, Healy and Hoyles (2001) and Hollebrands (2007) found that the usefulness of these systems depended greatly on students' background mathematics knowledge.

**Improved interest and motivation.** Students are more likely to practice solving problems in activities they find interesting and motivating. Some educators also

feel that students will become more active, spontaneous problem solvers if they experience success in their initial problem-solving efforts. For example, in reporting research results with problem-based environments such as the Alien Rescue software, Pedersen (2003) found that these environments can be highly motivational, although Samsonov, Pedersen, and Hill (2006) also found that this kind of software was more motivational to higher-achieving students.

**Prevents inert knowledge.** Content-area problem-solving environments, such as Thinkport's Flossville Town Park and Windjammer Environmental Center (<http://mathbydesign.thinkport.org/default.aspx>), can make knowledge and skills more meaningful to students because they illustrate how and where information applies to actual problems. Students learn both the knowledge and its application at the same time. Also, students gain opportunities to discover concepts themselves, which they frequently find more motivating than being told, or, as constructivists might say, being programmed with, the information (McCoy, 1990).

## Limitations and Problems Related to Problem-Solving Software

Problem-solving software packages are among the most popular of all software functions; however, the following issues are still of concern to educators:

**Names versus skills.** Software packages use many terms to describe problem solving, and their exact meanings are not always clear. Terms that appear in software catalogs as synonyms for problem solving include thinking skills, critical thinking, higher level thinking, higher order cognitive outcomes, reasoning, use of logic, and decision making. In light of this diversity of language, teachers must identify the skills that a software package addresses by looking at its activities. For example, for a software package that claims to teach inference skills, one would have to see how it defines inference by examining the tasks it presents, which may range from determining the next number in a sequence to using visual clues to predict a pattern.

**Software claims versus effectiveness.** It would be difficult to find a software catalog that did not claim that its products foster problem solving, yet few publishers of software packages that purport to teach specific problem-solving skills have data to support their claims. When students play a game that requires skills related to problem solving, they do not necessarily learn these skills. They may enjoy the game thoroughly—and even be successful at it—without learning any of the intended skills. Teachers may have to use problem-solving software themselves to confirm that it achieves the results they want.

**Possible negative effects of directed instruction.** Some researchers believe that direct attempts to teach problem-solving strategies can actually be counterproductive for some students. Mayes (1992) reports on studies that found “teaching sequenced planning to solve problems to high-ability learners could interfere with their own effective processing” (p. 243). In a review of research on problem solving in

science, Blosser (1988) also found indications that problem-solving instruction may not have the desired results if the instructional strategy does not suit certain kinds of students. For example, students with high math anxiety and low visual preference or proportional reasoning abilities will profit from instruction in problem solving only if it employs visual approaches.

**Transfer.** Although some educators feel that general problem-solving skills, such as inference and pattern recognition, will transfer to content-area skills, scant evidence supports this view. In the 1970s and 1980s, for example, many schools taught programming in mathematics classes under the hypothesis that the planning and sequencing skills required for programming would transfer to problem-solving skills in math. Research results never supported this hypothesis. In general, research tends to show that skill in one kind of problem solving will transfer primarily to similar kinds of problems that use the same solution strategies. Researchers have identified nothing like “general thinking skills,” except in relation to intelligence (IQ) variables.

## Using Problem-Solving Software in Teaching

Problem-solving software can serve several classroom needs. This section describes integration strategies to meet each of these needs and offers guidelines and practical tips on how to integrate these strategies in the classroom.

**Classroom integration strategies for problem-solving software.** Integration strategies for problem-solving software vary considerably depending on whether the desired approach is directed or constructivist. The following are guidelines for both integration strategies. Problem-solving software is appropriate for the following instructional needs:

- » **To teach component skills in problem-solving strategies**—Many problem-solving packages provide good, hands-on experience with one or more of the skills required to use a problem-solving approach. These include identifying and following a logical sequence, identifying relevant information to solve problems, not jumping to conclusions too quickly, and remembering relevant information.
- » **To provide support in solving problems**—Some software packages are specifically designed to scaffold students as they practice solving complex problems. For example, *Geometer's Sketchpad* helps students draw objects and investigate their mathematical properties.



» **To encourage group problem solving**—Some software provides environments that lend themselves to solving problems in small groups. For example, software at the Thinkport site (<http://mathbydesign.thinkport.org/default.aspx>) provides opportunities for collaborative problem solving.

**Guidelines for directed teaching.** Usually, teachers want to teach clearly defined skills. To teach problem solving, they must decide which particular kind of problem-solving ability students need to acquire and how best to foster it. For example, Stokes (1999) recommends that students use a teacher-designed reflection sheet and keep a log of problem-solving strategies and outcomes. With clearly identified skills and a definite teaching strategy, problem-solving software has unique abilities to help focus students' attention on required activities. This kind of software can get students to apply and practice desired behaviors specific to a content area, or more general abilities in problem solving if use in a content area follows.

The following six steps can help you integrate problem-solving software for directed teaching:

1. Identify problem-solving skills or general capabilities to build or foster skills in:
  - solving one or more kinds of content-area problems (e.g., building algebra equations);
  - using a scientific approach to problem solving (i.e., identifying the problem, posing hypotheses, planning a systematic approach); and
  - identifying the components of problem solving, such as following a sequence of steps or recalling facts.
2. Decide on an activity or a series of activities that will help teach the desired skills.
3. Examine software to locate materials that closely match the desired abilities, remembering not to judge capabilities on the basis of vendor claims alone.
4. Determine where the software fits into the teaching sequence (for example, to introduce the skill and gain attention, as a practice activity after demonstrating problem solving, or both).
5. Demonstrate the software and the steps to follow in solving problems.
6. Build in transfer activities and make students aware of the skills they are using in the software.

**Guidelines for using constructivist strategies.** Like many technology resources, some software with problem-solving functions is designed for more constructivist approaches to learning. These models give students no direct

training in or introduction to solving problems; rather, they place students in highly motivational problem-solving environments and encourage them to work in groups to solve problems. The following seven steps can help you integrate problem-solving software according to constructivist models:

1. Allow students sufficient time to explore and interact with the software, but provide some structure in the form of directions, goals, a work schedule, and organized times for sharing and discussing results.
2. Vary the amount of direction and assistance provided, depending on each student's needs.
3. Promote a reflective learning environment; let students talk about the methods they use.
4. Stress thinking processes rather than correct answers.
5. Point out the relationship between software activities and other kinds of problem solving.
6. Let students work together in pairs or small groups.
7. For assessments, use alternatives to traditional paper-and-pencil tests.

For an example of a problem-solving software that supports both directed and constructivist applications, see Technology Integration Example 5.

## INTEGRATED LEARNING SYSTEMS

**Integrated learning systems (ILSs)** are networked or online systems that provide both computer-based instruction and track and report on student progress. The most powerful—and the most expensive—of available instructional software products, ILSs were introduced in the early 1970s and, until the emergence of the Internet, were delivered via computer network from a central computer (server), usually located in the school. Initially, students and teachers used the instructional and management systems from terminals or microcomputers connected to the server. More recently, ILS-type capability is provided by offering the curriculum online via the Internet rather than through a local network.

» Regardless of the delivery system, an ILS is characterized as a “one-stop shopping” approach to providing software. Each ILS offers a variety of instructional techniques in one place, usually as a curriculum package complete with technical maintenance and teacher training. In addition to providing a combination of

## TECHNOLOGY INTEGRATION EXAMPLE 5

### PROBLEM-SOLVING SOFTWARE

**TITLE:** Wait for a Date: Calculating Probability with *Geometer's Sketchpad*

**CONTENT AREA/TOPIC:** Mathematics—Precalculus

**GRADE LEVELS:** 8–10

**NETS FOR STUDENTS:** Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Mathematics; Critical Thinking and Problem Solving—Solve problems; ICT Literacy—Apply technology effectively

**DESCRIPTION:** The teacher presents students with a scenario: “You and a friend arrange for a lunch date next week between 12:00 and 1:00 pm. However, neither of you remembers the exact meeting time. Each of you arrives at a random time between 12:00 and 1:00 pm and waits exactly 10 minutes, then leaves if the other person has not come. Under these circumstances, what is the probability that you two will meet?” Students use a pre-made Sketchpad model (available at the *Geometer's Sketchpad* site) to gather sample data and, by viewing data as points in a plane, they uncover a geometric pattern that allows them to compute a precise probability. Sketchpad also supports activities called “black box tasks” for students with more sophisticated knowledge of the software. In these activities, students use the software to re-create a given figure or deduce underlying properties that two or more objects have in common.

**Source:** Based on lesson plan idea at the *Geometer's Sketchpad* website: <http://www.keypress.com/x5610.xml>

drill-and-practice, tutorial, simulation, problem-solving, reference, and tool software, an ILS is capable of maintaining detailed records on individual student assignments and performance and supplying printouts of this information to teachers.

The teacher usually makes initial assignments for work on the system, monitors student progress by reviewing ILS reports, and provides additional instruction or support where needed. As each student signs on to a microcomputer connected to the server or Internet, the file server sends (or downloads) student assignments and software to the station and proceeds to keep records on what the student does during the time spent on the system.

## ILS Software Components

Instructional activities available on an ILS range from simple drill and practice to extensive tutorials. Many ILSs are moving toward complete tutorial systems intended to replace teachers in delivering entire instructional sequences. An ILS usually includes instruction on the entire scope and sequence of skills in a given content area; for example, it may cover all discrete mathematics skills typically presented in grades 1 through 6.

## ILS Management System Components

The capability that differentiates ILSs from other networked systems is the emphasis on individualized instruction tied to records of student progress. A typical ILS gives teachers progress reports across groups of students, as well as the following kinds of information on individual performance:

- » Lessons and tests completed
- » Questions missed on each lesson by numbers and percentages
- » Numbers of correct and incorrect tries
- » Time spent on each lesson and test
- » Pre-test and post-test data.

## Selecting ILSs

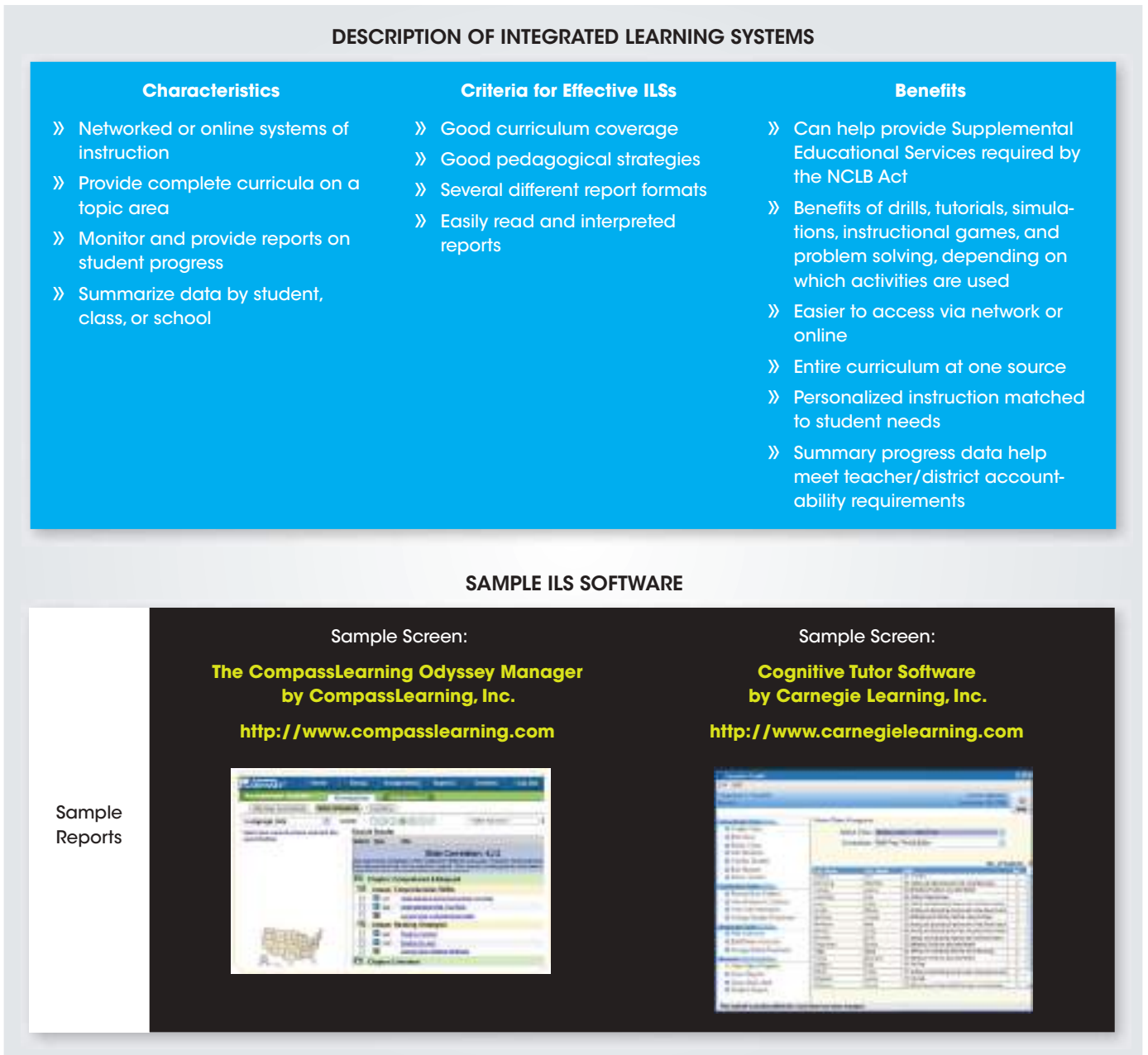
One way to ensure the appropriate use of ILSs is to have a careful, well-planned initial review process that involves both teachers and school administrators. Criteria for the selection process are usually based on the curriculum coverage and pedagogical strategies in the ILS, as well as perceptions about the usefulness of the reports that the system produces and to what extent they meet the needs of the district. See Figure 6 for examples of ILS progress reports and a summary of ILS features.

## Benefits of ILSs

ILSs have become popular in school districts for their “one-stop shopping” approach to buying software, as well as their ability to provide achievement information by student, teacher, class, or school. Two developments related to school and teacher accountability have made these products especially appealing:

**District- and state-adopted academic standards.** An increased emphasis on educational accountability in the 1990s caused states to set curriculum standards and create tests to measure students’ progress on them. Integrated software and management assessments aligned with these standards helps schools prepare for meeting them.

**FIGURE 6** Integrated Learning System (ILS) Functions in Brief



Source: Used by permission of CompassLearning, Inc. CompassLearning Odyssey is a registered trademark of CompassLearning, Inc. Cognitive Tutor Software © Carnegie Learning, Inc. All rights reserved.

**Accountability requirements of the No Child Left Behind (NCLB) Act.** The NCLB Act stipulated that schools who fail to meet Adequate Yearly Progress (AYP) for 3 years in a row must use a portion of their Title I funds for out-of-school tutoring, which the NCLB Act refers to as Supplemental Educational Services. ILS materials are ideal for providing these services.

Since an ILS provides a combination of the materials described previously in this chapter, its potential benefits

duplicate the benefits of those functions. In addition to those benefits, ILS networked or online materials are easy for teachers and students to access and can provide entire curricula from one location. Prepared curricula and ease of use mean that school personnel need not know a great deal about technology to use an ILS. Consequently, they usually simplify integration decisions by defining school-wide curriculum rather than individual lessons. When teachers assign some students to use ILS activities, it frees time for them to help

other students who need their personal assistance. In addition, teachers can personalize instructional activities for each student by reviewing the extensive information on student and class progress provided by the ILS management system.

## Limitations and Problems Related to ILSs

Teachers should note that although many educators still refer to these multifaceted systems as “integrated learning systems,” the vendors of the systems tend to refer to them as “educational solutions,” “accountability solutions,” or “supplemental educational services” (Readers’ Choice Awards, 2004). By whatever name, several items are ongoing concerns:

**The cost of ILSs.** The primary criticism of ILSs centers on their expense as compared to their impact on improving learning. ILS proponents feel that the students who experience the most success with ILSs are those whose needs are typically most difficult to meet. Proponents also say there is value in any system that helps potential dropouts stay in school or helps students with learning disabilities. They point to studies and personal testimony from teachers over the years that ILSs motivate students by allowing them to work at their own pace and to experience success each time they are on the system.

**Research on ILS impact.** Kulik’s (2003) meta-analysis of ILS studies published between 1990 and 1997 shows modest gains for schools using ILSs. However, more recent large-scale studies using controlled experimental methods show no significant differences in achievement between classrooms using these systems and those using traditional materials and methods (U.S. Department of Education, 2010; Wijekumar, Hitchcock, Turner, Lei, & Peck, 2009). Large-scale studies of ILS use in the United Kingdom (Wood, Underwood, & Avis, 1999), Indiana (Estep, McInerney, & Vockell, 1999–2000), and New York (Miller, 1997; Paterson, Henry, & O’Quin, 2003) found that the impact of an ILS on student achievement varies greatly with implementation methods.

**Concerns about the role of ILSs.** In a follow-up to his literature review on ILS uses, Becker (1994) criticized uses of ILSs that encourage “mindless adherence to the principle of individualized instruction” (p. 78). However, an early concern expressed by many educators that the cost of ILSs combined with the comprehensive nature of their curricula might cause schools to view them as replacements for teachers has not yet proven to be a real problem.

## Using ILSs in Teaching

When used only as a teacher replacement to provide individual student instruction, ILSs seem to be less effective.

When viewed as a supplement to other teaching methods and carefully integrated into a total teaching program, they seem more likely to have the desired impact on raising achievement. One way to ensure appropriate and cost-effective uses of ILS products may be through a careful, well-planned purchasing process that involves both teachers and administrators.

**Directed applications for ILSs.** In a directed teaching approach, an ILS system can be used for remediation and as a mainstream delivery system. With either of these applications, teachers still have important roles to play. They must assign initial levels of work, follow up on student activities on the system, and give additional personal instruction when needed.

» **For remediation**—Although ILSs are expensive alternatives to other delivery systems, the requirements of the federal and state accountability mandates have provided new motivation—as well as new funding sources—for using them. Even when new funding and the motivation to use ILSs are present, schools must determine how ILS functions coordinate with and complement those of the classroom teacher. ILSs serve target populations that have typically presented the most difficult problems for traditional classroom activities: Title I groups, English Language Learners (ELL), special education students, and at-risk students. Schools have tried and usually failed to reach these students with other methods.

» **As a mainstream delivery system**—Rather than using an ILS only as a backup system to address educational problems, a school may let an ILS do the initial job of teaching whole courses for all students in a grade level. In light of the expense of ILSs, this type of use is more rare. However, some alternative projects, like the Edison Project (Walsh, 1999), predict that the costs of using technology in this way will amount to substantially less over time than teacher salaries. Using ILSs to increase student-to-teacher ratios has stimulated ongoing debate and study.

**Constructivist applications for ILSs.** An ILS can also combine several kinds of technology resources to support constructivist learning approaches. This kind of ILS can provide a rich environment that students can use to construct their own knowledge. ILS products useful for constructivist purposes typically have an array of resources, such as computer simulations and/or problem-solving software, as well as data-collection systems to track student usage of the system.



# SUMMARY

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

## 1. Introduction to instructional software

- » Instructional software (a.k.a., computer-assisted instruction or courseware) are computer programs designed specifically to deliver instruction or assist with the delivery of instruction on a topic.
- » Functions fulfilled by instructional software include: drill-and-practice, tutorial, simulation, instructional game, or problem-solving programs, but programs that include all these functions plus more are also available as integrated learning systems (ILSs).
- » Recent developments in instructional software include: increased use of online access, multi-platform use, multimedia and game formats, and renewed emphasis on directed strategies.

**2. Drill-and-practice software functions**—These are programs that provide exercises in which students work example items, usually one at a time, and receive feedback on their correctness.

- » Types of drill and practice include: Flash card activities, chart fill-in activities, branching drills, and extensive feedback activities.
- » Integration strategies for drill-and-practice software are: To supplement or replace worksheets and homework exercises, and to prepare for tests.

**3. Tutorial software functions**—These are programs that provide an entire instructional sequence on a topic, similar to a teacher's classroom instruction.

- » Types of tutorials include: Linear and branching activities.
- » Integration strategies for tutorial software are: To provide alternative learning strategies and to give instruction when teachers are unavailable.

**4. Simulation software functions**—These are programs that provide computerized models of a real or imagined system that is designed to teach how the system works.

- » Types of simulations include: Products that teach about something, which include physical and iterative simulations;

and products that teach how to do something, which include procedural and situational simulations.

- » Integration strategies for simulation software are: To use in place of or as supplements to lab experiments, role-playing, or field trips; to introduce and/or clarify a new topic; to foster exploration and process learning; and to encourage cooperation and group work.

**5. Instructional game functions**—These are programs that add game-like rules and/or competition to learning activities.

- » Types of instructional games include: The same as for drills and simulations, dependent on the game format.
- » Integration strategies for simulation software are: To use in place of worksheets and exercises, to teach cooperative group working skills, and to use as a reward.

**6. Problem-solving functions**—Software designed especially for the purpose of teaching component skills in problem solving.

- » Types of problem-solving programs include: Programs to teach content-area and content-free problem-solving skills.
- » Integration strategies for simulation software are: To teach component skills in problem-solving strategies, to provide support in solving problems, and to encourage group problem solving.

**7. Integrated learning systems (ILSs)**—These are networked or online systems that provide both computer-based instruction and track and report on student progress.

- » Components of ILSs include: Instructional sequences and skill practice and a management system that gives reports on student progress.
- » Integration strategies for ILS software are: Directed uses (to provide remediation and to provide a mainstream delivery system) and constructivist uses (to provide a "rich environment" that students can use to construct their own knowledge).



# 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 College Board has joined the American Chemical Society ([http://portal.acs.org/portal/PublicWebSite/policy/publicpolicies/invest/computersimulations/WPCP\\_011381](http://portal.acs.org/portal/PublicWebSite/policy/publicpolicies/invest/computersimulations/WPCP_011381)) and the National Science Teachers Association (<http://www.nsta.org/about/positions/laboratory.aspx>) in objecting to simulated lab software (e.g., online frog dissections, mixing chemicals) when used to replace in-class, hands-on labs. Read the ACS and NSTA statements and analyze the objections they voice. What evidence can you cite to support or refute their positions?
- 2.** The perception that drill-and-practice software is a “drill and kill” activity is based on misuses of the practice activity. What are occasions in which drill and practice does and does not lead to better performance? Read for background: the Education Next review (<http://educationnext.org/false-claim-on-drill-and-kill>), the APA slideshow (starts at <http://www.apa.org/education/k12/practice-acquisition.aspx>), and the theories of E. D. Hirsch (for example, at <http://www.newfoundations.com/GALLERY/Hirsch.html>).

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your **Technology Integration Lesson Planning** exercises
- » Artifact you create from one of the Project Based Assignments on the MyEducationlab for your course

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions that follow it.

*Ms. Francisco is a ninth grade science teacher who has always faced several challenges in teaching anatomy using frog dissections. For example, some students became ill from the formaldehyde, and some objected on ethical grounds to animals being used in this way. This always hampered students getting full benefit from this unit. Despite these issues, her anatomy units have always been largely successful thanks to her in-depth knowledge of anatomy and her ability to connect students with comparative anatomy concepts in which they apply frog anatomy to the human body. She realizes that teaching anatomy effectively using these technologies is quite different from teaching the concepts through the traditional dissections. She resolves to attend professional development workshops on how to teach effectively using simulations. Also, as she considers using virtual dissections as a supplemental activity, she reviews the Digital Frog software and V-Frog online simulations. Then she sees a frog dissection app on her iPad. Since the school district*

is offering classroom sets of iPads to any teachers who can propose innovative strategies for engaging females with science, she considers proposing this topic to the district.

- a. Deconstruct Ms. Francisco’s Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that Ms. Francisco must address to implement this new strategy effectively in her classroom.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need the most appropriate combination of technological,

pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the types of instructional software you learned about in this chapter. The technology should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



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.



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# TECHNOLOGY TOOLS FOR 21ST CENTURY TEACHING

## THE BASIC SUITE

# TECHNOLOGY TOOLS FOR 21ST CENTURY TEACHING

## THE BASIC SUITE

Hence, could a machine be invented which would instantaneously arrange on paper each idea as it occurs to us... how extremely useful would it be considered.

Henry David Thoreau, as quoted by David Humphries, *Computers in English and the Language Arts: The Challenge of Teacher Education* (1989)

### o u t c o m e s

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

1. For a given instructional or productivity activity, identify which of the "basic three" software tools would be most appropriate to support the activity.
2. Apply software features and capabilities to develop word-processed products and instructional activities that integrate word processing functions and capabilities.
3. Apply software features and capabilities to develop spreadsheet products and instructional activities that integrate spreadsheet functions and capabilities.
4. Apply software features and capabilities to develop presentation products and instructional activities that integrate presentation software functions and capabilities.



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### key terms

cell  
computer platforms  
database software  
files

formula  
Google Docs  
integrated packages  
open-source software

presentation software  
software suites  
spreadsheets  
worksheets



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## TECHNOLOGY INTEGRATION IN ACTION: CAN YOU AFFORD YOUR DREAM CAR?

GRADE LEVEL: Middle to high school • CONTENT AREA/TOPIC: Applied math skills • LENGTH OF TIME: One week

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

Whenever Ms. Kiley teaches her applied mathematics class for grades 9 through 12, she has teenagers of many ages and ability



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levels. She wants all of them to have experience applying math skills to real problems they will encounter in their daily lives. She tries to include projects that are interesting and relevant to all of them and that require a combination of research, mathematical problem solving, and production skills. One activity she found that meets all her criteria is called "Can You Afford Your Dream Car?" She selected this project from a list she found on the Internet and felt it would be a much better way to teach these concepts than she had used before. Almost all of her students are beginning drivers and are interested in car purchases, and, so that they can do calculations quickly and focus on the underlying concepts (e.g., the relationship among down payment, interest rate, and loan period), she would create a template with spreadsheet software for students to use. Each student would do Internet research to locate the best price on a car he or she would like to buy. Then they enter the information into the spreadsheet template and present their findings to the class, answering various questions about loan amounts and car payments.

#### Step 2: Assess Tech-PACK.

**Technology Domain.** Ms. Kiley had learned about spreadsheets in a workshop held by her local professional organization, but she had never created a worksheet template like the one called for



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in the lesson. However, she felt she could figure out how to do it from the notes in the lesson plan. After working with spreadsheet software, she learned how to create the template, save it onto a disc, and transfer it to the students' computers. Then she worked with the spreadsheet in order to get proficient enough with the software to help her students.

**Content and Pedagogical Domains.** She felt very comfortable with the content she would be teaching; she knew the mathematical concepts very well. She had taught students about the interrelationships among car price, interest rate, and loan term before, but they hadn't been very interested. Ms. Kiley anticipated that this project would spark their interest much more than other ways of teaching these concepts. She reviewed the lesson plan notes carefully and thought about how she would use the spreadsheet to help her explain the underlying ideas.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

To keep her students on track and to make sure they learn what she has in mind for this project, Ms. Kiley created objectives and

assessments to measure their research, problem-solving, and production outcomes. The outcomes, objectives, and assessments are:

- » **Outcome:** Select a car to purchase and complete background research on it. **Objective:** Each student completes all required steps to select a car to "buy"; completes a list of the activities required to research and locate comparison information about its price, loan, and features; and enters the information into a spreadsheet template. **Assessment:** A checklist with points for each required activity.
- » **Outcome:** Do mathematical problem solving. **Objective:** Each student uses the spreadsheet to answer a series of questions about the amount of the car loan and the payments at various interest rates and time periods. **Assessment:** Worksheet questions with points for each one; 80% is passing.
- » **Outcome:** Do a final report. **Objective:** Each student achieves a rubric score of at least 90% on a word-processed report that describes and illustrates the car, tells why it is a cost-effective purchase, and includes a spreadsheet (based on the template provided) showing how he or she will pay for it. **Assessment:** Rubric on report quality and accuracy.

### Step 4: Design integration strategies.

Ms. Kiley wanted to make sure each student had hands-on experience with the research and production activities and was able to master each of the skills she outlined, so she decided to make this an individual activity. She designed the following activity sequence to carry out the project:

- » **Day 1:** Introduce the project. Encourage students to talk about cars they have already purchased or are considering purchasing, and ask them to describe how they went about selecting one and, if they actually bought it, how they decided on a loan amount, term, and payment size. Demonstrate the spreadsheet template, and show students how the payments and total amount paid change automatically depending on the loan amount, interest, and period

## INTRODUCTION TO THE BASIC SOFTWARE TOOL SUITE

In education and, indeed, in most other areas of modern society, three of the most widely used software support tools are word processing, spreadsheet, and presentation programs. For many professionals in education and other fields, these tools have become an indispensable part of their daily work. They are frequently sold as software suites, separate tool programs placed in the same package and designed to work well together. Teachers choose them not only because

they have qualities that aid classroom instruction and help make classroom time more productive, but also because they give students experience with 21st century tools that they will see again and again in their workplaces.

### Why Use Software Tools?

Depending on the capabilities of the tool and the needs of the situation, these programs can offer several benefits:

- » **Improved productivity**—Getting organized, producing instructional materials, and accomplishing

entered into the spreadsheet. Review the project checklists and rubrics as well as the timeframe for completing the work. Introduce the problems students are to work using their completed spreadsheets.

- » **Day 2:** Take students to the computer lab, and demonstrate some of the sites they may want to use to check out makes and models of cars. Also, demonstrate once again how to use the spreadsheet template. Have students do some calculations with the spreadsheet, and answer any questions they have. Let them begin researching cars they want to buy.
- » **Day 3:** In the computer lab, allow students to continue their research. Some students may have completed research on their home computers. These students can begin work on their final reports or complete the problem-solving exercise.
- » **Day 4:** In the computer lab, allow students to continue work on their reports and the exercises with the spreadsheet template.
- » **Day 5:** Back in the classroom, let selected students present their “dream car purchase.” Use the classroom computer workstation to show an online example of the car model and the dealer from which they would buy it. Students who need more time can go to the computer lab.
- » **Day 6:** Students turn in their projects and exercises.

### Step 5: Prepare instructional environment.

The first time Ms. Kiley taught this project, she had to create the spreadsheet template and handouts of the checklists and rubric for students to use. For subsequent times, she had to do the following:

- » **Handouts:** Ms. Kiley made copies of the project requirements and grading criteria sheets (i.e., checklists and rubrics) to hand out to students. She also made sure these handouts were online at her classroom website as PDF files, so students could download additional copies if needed.
- » **Software skills:** Although Ms. Kiley demonstrated how to use the spreadsheet template, she checked with students

individually as they worked in the lab to make sure they knew how to enter the required information in the cells and could copy and paste their completed worksheet into their report.

- » **Computer scheduling:** Ms. Kiley made sure she could have her whole class in the computer lab for the 3 days she would need it; she also made sure individual students could come to the lab for the 2 subsequent days to complete their research and reports.
- » **Template copies:** Ms. Kiley made sure that a copy of the template was on the classroom website so that students could download it to their own discs.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

Each time she taught the project, Ms. Kiley reviewed students’ work and asked for their comments on how she could make the project even more meaningful. She quickly realized that students who did not have a home computer were at a disadvantage in completing the work in a timely way. She found that, although students usually completed their spreadsheets correctly and could answer questions about them, their reports varied considerably in quality.

### Step 7: Make revisions.

In light of the fact that not all students had a home computer with the required software, Ms. Kiley made a special effort to help these students during their time in the lab and made sure they knew they could have additional lab time outside class or before or after school to use the classroom workstation. Also, since students’ written reports did not always meet required criteria, she decided to consider other ways of having students present their work.

paperwork tasks all go much faster when software tools are used. Using a technology tool to do these tasks can free up valuable time that can be rechanneled toward working with students or designing learning activities.

- » **Improved appearance**—Software tools help teachers and students produce polished-looking materials that resemble the work of professional designers. The quality of classroom products is limited only by the talents and skills of the teachers and students using the tools. Students appreciate receiving attractive-looking

materials and find it rewarding and challenging to produce handsome products of their own.

- » **Improved accuracy**—Software tools make it easier to keep precise, accurate records of events and student accomplishments. More accurate information can support better instructional decisions about curriculum and student activities.
- » **More support for interaction and collaboration**—Software tools have capabilities that promote interaction and collaboration among students, allowing input from



## ADAPTING FOR SPECIAL NEEDS

### Word Processing and Other Basic Software Tools

Word processing skills are expected of all students across all subjects and grades. However, some students with disabilities have difficulty with this task because of physical, sensory, or cognitive impairments that interfere with written expression. In order to support struggling writers, educators may use tools like the following that encourage written expression for diverse learners:

- » **Clicker Writer** (<http://www.cricksoft.com>)—A word processor that lets students click on letters, words, or short phrases to send into the word processor, so they can write sentences without using the keyboard.
- » **Co:Writer** (<http://www.donjohnston.com>)—A word prediction program that helps students who have illegible

handwriting, poor phonetic spelling, a physical disability that makes typing difficult, or difficulty translating thoughts into writing.

- » **Picture It** (<http://www.slatersoftware.com>)—Allows teachers to create picture-assisted reading materials to help struggling readers and writers.
- » **Scholastic Keys (formerly called Max's Toolbox)** (<http://www.tomsnyder.com>)—Gives elementary students an early introduction to using *Microsoft Office* by providing a kid-friendly interface for *Word*, *Excel*, and *PowerPoint*.

Contributed by Dave Edyburn

several people at once. These qualities can encourage creative, cooperative group-learning activities. (For hints on making sure these powerful tools are available to all students, see the Adapting for Special Needs feature.)

### Overview of Uses for the “Basic Three” Software Tools

Since the early days of microcomputers, word processing and spreadsheet programs have served as two of the most basic components in the teacher’s “technology toolkit.” **Database software**, a program that allows information to be collected and organized to allow easy retrieval through keyword searching, used to be one of the basic programs, but, though still used in education and elsewhere, it is not typically sold as part of the basic suite anymore. Instead, presentation programs have emerged in its place. As

Table 1 shows, each of these programs performs specific functions and each helps support specific productivity and teaching/learning activities. However, the three programs are usually designed to work together. For example, in the Technology Integration in Action Example at the beginning of this chapter, a student completes a spreadsheet that demonstrates a mathematical concept (loan terms), and then he or she inserts this spreadsheet into a word-processed report or presentation.

**Overview of productivity uses.** These three software products are often referred to as the “basic productivity tools,” because they were among the first such tools to be designed to save time on clerical types of tasks and because they are now the ones that software companies such as Microsoft most often include in their software suites. In schools, word processing is the most frequently used of the three for productivity purposes, since teachers and students use it across

**TABLE 1** An Overview of the “Basic Three” Software Tools

Software Tool	Software Functions	Sample Products
Word Processing Example: Microsoft <i>Word</i>	Creates documents consisting of pages with text and graphics	Student compositions, poetry, and reports; flyers; simple newsletters; letters
Spreadsheet Example: Microsoft <i>Excel</i>	Puts numerical information in row-column format; allows quick calculations and recalculations	Budgets, checkbooks, gradebooks, illustrations of mathematics concepts
Presentation Example: Microsoft <i>PowerPoint</i>	Displays text and graphics (with or without audio) in a slide show	Teacher demonstrations and support for lectures, student projects, book reports, and practice items

all subject areas whenever they need to do typed work, such as a composition or report. Spreadsheet software also enhances teacher and student productivity by allowing more efficient work with numbers, and **presentation software**, programs that allow display of information organized as a set of slides, helps them communicate complex information more quickly.

**Overview of instructional uses.** Word processing is used primarily to support English and foreign language exercises, such as learning vocabulary and punctuation. **Spreadsheets** are programs that allow storage of data by row–column positions, and are used most often for demonstrations in mathematics, science, and business education areas. They also support instructional activities, such as science experiments or social studies surveys. Presentation software is used across all content areas, but it has become especially popular in business and journalism to show students how to design graphics and other media that communicate concepts clearly and persuasively.

## Recent Developments in Software Tools

Although software tools have been in existence for many years, they are constantly being updated with new features and capabilities. The following developments have made these tools even more useful in the classroom:

- » **Web-based collaboration tools**—There has been a surge of software tools that are now available via the Internet, and many are free of charge. **Google Docs**, for instance, is a tool that provides users access to online programs for word processing, spreadsheets, and presentations. The site offers easy storage and sorting of documents in a “cloud computing” environment that allows for sharing of documents among multiple users. Barack (2010) reports that “Google apps [applications] for education has districts nationwide moving to the cloud” (p. 12).
- » **Open-source software**—**Open-source software**, computer software whose source code is made available in the public domain and that permits users to use, change, and improve the software and to redistribute it in modified or unmodified form, is also becoming more popular, with open-source alternatives to many of the most popular programs now available. See a summary of open-source software tools on the next page.
- » **Mobile tools**—All of the basic software tools are now available on tablets and handheld devices. This portable format makes them easily accessible and flexible to use for both teachers and students. Since these basic

software tools have been transferred to handheld format, the handhelds themselves have become even more popular and useful.

- » **Web-enabled features**—All of the basic software tools now allow insertion of “live” web page links in documents, and most allow documents to be saved in Hypertext Markup Language (HTML) or other web page formats. This makes it even easier to connect documents to web page resources that embellish or add to the document’s content. For example, students may include links in a project report to some of the resources they consulted during their research.
- » **Better file-exchange compatibility**—In the early days of software tools, programs were often incompatible. That is, **files**, products created in one program, could not be opened in another program. Incompatibility was especially problematic between programs on Macintosh and Windows (PC) computers. This problem limited file sharing and hindered collaborative work, since people often had different **computer platforms** or types of computer operating systems (e.g., Macintosh vs. Windows) and tool programs. Today’s software tools, both online and on a local computer, are designed to be much more compatible across programs and platforms, making it much easier for teachers and students to transfer documents and to work together on projects.
- » **Software suites and integrated packages**—Because it is usually cheaper to buy several tools as a package rather than separately, tool functions are increasingly used as parts of **software suites** or **integrated packages**. However, there is a difference between **integrated packages**, which combine several functions such as word processing, spreadsheet, database, and graphics working under one program, and **software suites** or separate programs that companies place in the same package. There are software suites for all platforms. Apple developed the *iWork* suite for use on all Apple hardware; it includes *Pages* for word processing, *Keynote* for presentations, and *Numbers* for a spreadsheet. Similarly, *Microsoft Office* is a software suite for both Macintosh and Windows-based systems and includes Microsoft *Word*, Microsoft *Excel*, and Microsoft *PowerPoint*.

## USING WORD PROCESSING SOFTWARE IN TEACHING AND LEARNING

Word processing programs allow people to produce typed documents on a computer screen. Although the lines



# Free open source **OPTIONS** for Productivity Software Sites

**TYPES****FREE SOURCES****Suites**

Feng Office (formerly OpenGoo): <http://www.fengoffice.com>  
 GNOME Office: <http://live.gnome.org/GnomeOffice>  
 Google Docs: <http://docs.google.com>  
 KOffice: <http://www.koffice.org>  
 NeoOffice: <http://www.neooffice.org>  
 Open Office: <http://www.openoffice.org>  
 Simple Groupware: <http://www.simple-groupware.de>

**Word processing**

AbiWord: <http://www.abisource.com>  
 Google Docs WP: <http://www.google.com/google-d-s/documents>  
 Writer: <http://why.openoffice.org/images/writer-big.png>  
 Zoho Writer: <http://writer.zoho.com>

**Spreadsheet**

Calc: <http://why.openoffice.org/images/calc-big.png>  
 Google Docs SS: <http://www.google.com/google-d-s/spreadsheets>  
 Gnumeric: <http://projects.gnome.org/gnumeric>  
 Simple Spreadsheet: <http://www.simple-groupware.de/cms/Spreadsheet/Home>

**Presentation**

Ease: <http://live.gnome.org/Ease/0.1>  
 Google Docs presentations: <http://www.google.com/google-d-s/presentations>  
 Impress: <http://www.openoffice.org/product/impress.html>

between word processing and desktop publishing have become increasingly blurred, the programs still differ in the way they produce documents. Word processing programs essentially produce documents as a stream of text, whereas desktop publishing produce them as individual pages. Despite this difference, most word processing programs allow at least some desktop publishing capabilities, such as inserting text boxes and graphics at any location on a page. Table 2 gives a list of word processing features.

## The Impact of Word Processing in Education

Perhaps no other technology resource has had as great an impact on education as word processing. This section reviews the reasons teachers use this software tool and the research that has been done to confirm its impact.

**Why teachers use word processing.** Not only does word processing offer high versatility and flexibility, it also is “model-free” instructional software—that is, it reflects no particular instructional approach. A teacher can use it to support any directed instruction or constructivist activity. Since its value as an aid to teaching and learning is universally acknowledged, word processing has become the most commonly used software in education. It offers many general relative advantages (unique benefits over and above other methods) to teachers and students:

- » **Saves time**—Word processing helps teachers use preparation time more efficiently by letting them modify materials instead of creating new ones. Writers can also make corrections to word processing documents more quickly than they could on a typewriter or by hand.

**TABLE 2 A Summary of Word Processing Features**

Feature Categories/ General Benefits	Word Processing Features	Description
<b>Basic features</b> save time writing text and make changing text easier and more flexible.	Store documents for later use. Store in many formats (e.g., RTF, PDF, HTML).	Documents saved to disc can be changed without reentering text. <ul style="list-style-type: none"> <li>Rich Text Format (RTF) removes all or most formatting commands so other word processors can read the file.</li> <li>PDF format allows files to be read as formatted documents with <i>Adobe Acrobat Reader</i>.</li> <li>HTML format allows documents to be placed on the Internet.</li> </ul>
	Erase and insert text.	Allows easy insertion of additional letters, spaces, lines, paragraphs, or pages.
	Search and replace.	One command allows all occurrences of a word or phrase to be changed as specified.
	Move or copy text.	Allows cutting and pasting (deleting text and inserting it elsewhere) or copying and pasting (repeating text in several places).
	Allow word wraparound.	Automatically goes to next line at end of a line without pressing Enter or Return. (Also hyphenates words, as needed.)
<b>Desktop publishing features</b> make flyers, reports, newsletters, brochures, and student handouts more attractive and professional looking.	Alignment.	Centers or justifies (right, left, or full).
	Change styles/appearance.	Allows a variety of fonts, type styles, font colors, margins, line spacing, tabs, and indentations in the same document.
	Insert automatic headers, footers, and pagination.	Automatically places text at the top (header) or bottom (footer) of each page in a document with or without page numbering (pagination).
	Insert graphics.	Inserts clip art or image files into documents and formats them: some programs allow image editing.
	Insert colors and shading.	Graphics can be filled with color or degrees of shading.
	Insert tables.	Organizes information into rows and columns without using tabs or indentations.
	Insert text boxes.	Allows text blocks to be inserted in any location in or around a document.
	Insert drawn figures.	Allows inserting shapes, callouts, and other figures to enhance documents.
<b>Language features</b> help teachers and students correct their work and do various language, spelling, and usage exercises.	Check and correct spelling.	Spell-checker feature compares words in a document to those stored in the program's dictionary files.
	Suggest words.	Thesaurus feature suggests synonyms for any word.
	Check grammar and usage.	Grammar checkers review documents for items such as sentence length, frequency of word use, and subject-verb agreement. Also marks phrases or sentences to be corrected.
<b>Web features</b> allow teachers and students to connect documents with Internet resources and create web page announcements, reports, and projects.	Insert "live" URLs.	Allows person reading the document to click on text and go automatically to a website. ( <i>Note: Web browser must be active.</i> )
	Create web pages.	Acts as simple web page development software and creates HTML pages.
<b>Support features</b> make using the program easier and more flexible.	Use templates.	Users can easily adapt preformatted models of resumes, newsletters, and brochures to their own needs.
	Offer voice recognition.	Allows text to be received and entered via dictated words rather than as typed entries.
	Merge text with data files.	<ul style="list-style-type: none"> <li>Automatically inserts words (e.g., names and addresses) into documents such as letters.</li> <li>Lists of data can be stored within the word processing program or merged from a database.</li> </ul>



# TOP TEN

## Integration Strategies for the Basic Three Software Tools

The best types and uses of software tools such as word processing, spreadsheets, and presentation software depend on the content area and skills teachers need to address. The ten uses given here are among the most popular ones described in the literature.

SOURCE	TRACK	SELECTION
Sweet hypothesis testing	1	Have students predict the average number of M&Ms or Skittles of each color in a package. Then count various packages and build a spreadsheet to display and chart the numbers and calculate averages.
Paragraph coherence	2	Show students how good paragraphs are put together by using word processing software to scramble sentences in a paragraph and having students use the copy-cut-paste feature to put the sentences in correct order.
Process writing	3	Have students use word processing software to do drafts of their compositions, have them email drafts to you, and send them corrections and suggestions in a different color type.
Colorful writing	4	Have students use the word processor's font color option to highlight and discuss various functions in compositions (e.g., topic sentences, emotion-evoking content, factual content, descriptive words and phrases).
Elections concepts	5	Use spreadsheet software to demonstrate how many ways a presidential candidate could win the popular vote but lose the electoral vote.
Pizza problem solving	6	Use a spreadsheet to calculate the most cost-effective pizza purchases to serve various numbers of people.
Teach-each-other presentations	7	For any series of related items or categories in curriculum (e.g., types of plants, animal phyla, chemical elements, historical events or figures), students choose or are assigned one of the items to research, create a presentation of their findings, and present it to the class, becoming teacher for that topic.
Online surveys	8	Show students how to do survey research by collecting data online and using a spreadsheet to receive and analyze it.
Political cartoons	9	Students use word processing and clip art to create political cartoons that illustrate various concepts and current events.
Book reports	10	Students present books they have read using a presentation software template that the teacher gives them. Students add graphics and text to complete their presentation and present their book to the class.





Perhaps no other technology resource has had as great an impact on education as word processing.

Photo by W. Wiencke.

- » **Enhances document appearance**—Materials created with word processing software look more polished and professional than handwritten or typed materials. It is not surprising that students seem to like the improved appearance that word processing gives to their work. This is especially possible with the many templates that are part of the software suites today.
- » **Allows sharing of documents**—Word processing allows materials to be shared easily among writers. Teachers can exchange lesson plans, worksheets, or other materials on disc and modify them to fit their needs. Students can also share ideas and products among themselves.
- » **Allows collaboration on documents**—Especially since the release of products such as Google Docs, teachers and students can now create, edit, and share documents synchronously. Both Green (2010) and Frederick (2008) summarize the collaborative advantages Google Docs offers and give many examples of such activities.

**Research on the impact of word processing.** Research on the benefits of word processing in education yields a variety of findings. Results of studies of the effects of word processing on quality and quantity of writing are mixed (Bangert-Drowns, 1993). Three reviews of research (Bangert-Drowns, 1993; Hawisher, 1989; Snyder, 1993) found that these differences in findings may reflect differences in researchers' choices of types of word processing systems, prior experience and writing ability of students, and types of writing instruction evaluated. Generally, word processing seems to improve writing and attitudes toward writing only if it is used in the context of good writing instruction and if students have enough time to learn word processing procedures before the study begins.

When Goldberg, Russell, and Cook (2003) updated these findings with a meta-analysis of studies from 1992 to 2002, they looked not only at whether word processing had more impact than handwritten methods, but also on when word processing could have the most impact on the quantity and quality of students' writing. Their meta-analysis showed a stronger relationship between computers and quality of writing than did previous such analyses. Students who use computers during writing instruction produce written work that is about 0.4 standard deviation better than students who develop writing skills on paper. Their analysis also suggested that when students write with computers, they “engage in the revising of their work throughout the writing process, more frequently share and receive feedback from their peers, and benefit from teacher input earlier in the writing process” (p. 19). Table 3 summarizes some of the findings of all four research reviews.

Dave and Russell (2010) observe that, though word processing does not necessarily lead to better quality writing, it definitely has had a dramatic impact on the practice of

**TABLE 3** Findings from Reviews of Word Processing in Education

	<b>Hawisher (26 studies) (1989)</b>	<b>Snyder (57 studies) (1993)</b>	<b>Bangert-Drowns (32 studies) (1993)</b>	<b>Goldberg, Russell, and Cook (14 studies) (2003)</b>
<b>Better quality of writing</b>	No conclusion	No conclusion	Positive results	Positive results
<b>Greater quantity of writing</b>	Positive results	Positive results	Positive results	Positive results
<b>More surface (mechanical) revisions</b>	No conclusion	Positive results	No conclusion	Not reviewed
<b>More substantive (meaning) revisions</b>	No conclusion	No improvement	No conclusion	Not reviewed
<b>Fewer mechanical errors</b>	Positive results	Positive results	Not reviewed	Not reviewed
<b>Better attitude toward writing</b>	Positive results	Positive results	No improvement	Not reviewed
<b>Better attitude toward word processing</b>	No conclusion	Positive results	Not reviewed	Not reviewed

writing. Noting that “drafting and revision were developed out of process theory and research done in the early 1980s . . . when word processing was not as pervasive or standardized as it is now” (p. 406), they find that this technology has altered our very definition of “draft” and made continuous revision a reality. However, they also note that most revisions remain concerned primarily with surface-level corrections, such as spelling and grammatical errors, and word processors seem to have had limited effect on promoting global revision, or overall improvements in depth and quality of written communication. “Despite the ease with which global revisions can be made with current word processors, students’ perception of the task of revision may not have changed much in this regard over the last 20 years” (p. 418). Dave and Russell also found that students tend not to print out work as much as they used to before word processors to help them revise their drafts, preferring to revise on-screen instead.

**Issues in using word processing.** Educators seem to agree that although word processing is a valuable application, its use in education can be controversial:

- » **Questions about what age students should start word processing**—Word processing software designed for young children is available, and schools can introduce word processing to students as young as 4 or 5 years old. Some educators feel that word processing will free students from the physical constraints of handwriting, allowing them to develop written expression skills. Others worry that it will make students unwilling to spend time developing handwriting abilities and other activities requiring fine-motor skills.
- » **Necessity to teach keyboarding skills**—Discussion is ongoing about whether students need to learn keyboarding (“10-finger typing” on the computer) either prior to or in conjunction with word processing activities. Some educators feel that students will never become really productive on the computer until they learn 10-finger keyboarding. Others feel that the extensive time spent on keyboarding instruction and practice could be better spent on more important skills, and that students will pick up typing skills on their own.
- » **Effects of word processing on handwriting**—While no researchers have conducted formal studies of the impact of frequent word processing use on handwriting legibility, computer users commonly complain that their handwriting isn’t what it used to be, ostensibly because of infrequent opportunities to use their handwriting skills. In addition, cursive writing, long a staple in elementary school curriculum, is on the wane, due in no small part to the influence of word processing and other technologies (Supon, 2009).
- » **Impact of word processing on assessment**—Some organizations have students answer essay-type test questions with word processing rather than in handwriting. Many school districts also allow students to word process their writing tests. This practice introduces several issues. Roblyer (1997) reviewed research that found that students’ word-processed compositions tend to receive lower grades than handwritten ones. This surprising finding indicates that educational organizations that allow students to choose either handwriting or word processing must be careful to establish guidelines and special training to ensure that raters do not inadvertently discriminate against students who choose word processing.
- » **Problems with inadvertent errors**—Link (2009) warns that the auto correction feature built into most word processors can replace typed words with ones the software selects as more correct, leading to typos that interfere with intended meaning. For example, Link noted that an important German article appeared in print with every instance of the correct phrase “DNA-Polymerase” changed to “DANN-Polymerase.” “Dann” means “then” in German, so the software replaced what it perceived as a misspelling with a known word. Teachers and students must be aware of this built-in feature and either turn it off or proofread even more carefully.

Teachers and administrators are still deciding how best to deal with these issues. Despite these obstacles, education’s dependence on word processing continues to grow.

## Word Processing in the Classroom: Productivity and Teaching Strategies

Word processing has a variety of benefits for both productivity and teaching practices. An overview of both these strategies is given here.

**Productivity strategies.** Word processing can help teachers prepare classroom materials they otherwise would have to type or write out by hand. These include handouts or other instructional materials, lesson plans and notes, reports, forms, letters to parents or students, flyers, and newsletters. Word processing saves preparation time, especially if a teacher uses the same documents every year. For example, a teacher may send the same letter to parents each year simply by changing the dates and adding new information. Teachers may want to keep electronic templates or model documents they can easily update and reuse. See Table 4 for a suggested list of reusable word-processed documents teachers may want to have on hand.

**TABLE 4 Suggested Items for a Teacher’s File of Reusable Word Processed Documents**

Documents
<ul style="list-style-type: none"> <li>• Beginning of the year welcome letter</li> <li>• Permission letters for field trips and other events</li> <li>• Flyers and other announcements</li> <li>• Request for fee payments letter</li> <li>• Fund-raising letter</li> <li>• List of class rules</li> <li>• Posted flyer of class rules</li> <li>• Letterhead stationery</li> <li>• Periodic student progress letters to parents</li> <li>• Lesson plans and notes</li> <li>• Students information sheets and handouts</li> <li>• Newsletters</li> <li>• Annual reports required by the school</li> <li>• Frequently used worksheets and exercises</li> </ul>

**Instructional integration strategies for word processing.**

Students can use word processing for almost any written work, regardless of subject area, that they would otherwise write by hand. Research shows that word processing alone cannot improve the quality of student writing but can help students make corrections more efficiently; this can motivate them to write more and take more interest in improving their written work. Some current word processing integration strategies include the following:

- » **Supporting the learning of writing processes**—Students can use word processing to write, edit, and illustrate stories; to produce reports in content areas; to keep notes and logs on classroom activities; and for any written assignments. Using word processing in the classroom can make it easier for students to get started writing as well as to revise and improve their writing. (See Technology Integration Example 1.)
- » **Using a dynamic group product approach**—Teachers can assign group poems or letters to various students, allowing students to add and change lines or produce elements of the whole document in a word processing program. Using word processing software, students find it easier to share, exchange, and add onto drafts, as well as to work together on written projects at a distance.
- » **Assigning individual language, writing, and reading exercises**—Special word processing exercises allow for meaningful, hands-on practice in language use as individual students work on-screen combining sentences, adding or correcting punctuation, or writing sentences for spelling words. Word processing may also make possible a variety of reading/language-related activities ranging from decoding

**TECHNOLOGY INTEGRATION EXAMPLE 1****WORD PROCESSING****TITLE:** Mystery Writers!**CONTENT AREA/TOPIC:** Language arts, creative writing**GRADE LEVELS:** 3–5**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 6—Technology Operations and Concepts**21ST CENTURY SKILLS:** Core subjects: English; Communication and Collaboration: Communicate clearly; Information, Media, and Technology Skills: Access and evaluate information; Media literacy: Create media products

**DESCRIPTION:** Students assume the identity of private investigators as they read, solve, and write mysteries in order to learn about the genre and encourage creative writing. The teacher helps students outline the critical elements of a mystery story and allows them to map a sample mystery to illustrate these elements and a story line. Then the teacher introduces nursery rhymes as mystery story-starters (e.g., Why did Humpty Dumpty fall off that wall? How did Mother Hubbard’s cupboard become empty?). Students organize their stories with a sticky-note story map, then word process their stories, doing drafts with teacher assistance.

**Source:** Based on a concept in an EducationWorld.com lesson at [http://www.educationworld.com/a\\_tsl/archives/02-1/lesson036.shtml](http://www.educationworld.com/a_tsl/archives/02-1/lesson036.shtml)

to writing poetry and enjoying literature. Identifying and correcting errors becomes a more visual process.

- » **Encouraging writing-through-the-curriculum**—A trend in education is to encourage writing skills in courses and activities other than those designed to teach English and language arts. This practice of writing-through-the-curriculum is in keeping with the emphasis on integrated, interdisciplinary, and thematic curricula. Word processing can encourage these integrated activities. (See Technology Integration Example 2.) Its font and graphics features allow students to represent concepts in mathematics, science, and other content areas. Word processors are also available in other languages to support foreign language learning.

**Teaching Word Processing Skills: Recommended Skills and Activities**

Students new to word processing must have adequate time to develop skills in using the software before teachers can begin

## TECHNOLOGY INTEGRATION EXAMPLE 2

### WORD PROCESSING

**TITLE:** The Language of Jazz—An Integral Part of American History and Culture

**CONTENT AREA/TOPIC:** Music/history

**GRADE LEVELS:** Elementary to middle school

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: History and Arts; Communication and Collaboration: Communicate clearly; Information, Media, and Technology Skills: Access and evaluate information; Media literacy: Create media products

**DESCRIPTION:** Students use the Internet to research the history of jazz and the life of one jazz musician and his or her effect on American culture. Then they use word processing software (Microsoft *Word*) to create a brochure about their musician and share it with the class. The Microsoft Education website provides step-by-step directions to carry out the lesson and two handouts for students (prepared with Microsoft *Word*).

**Source:** Based on a concept in a Lesson Plan from Microsoft Education collection at <http://www.microsoft.com/education/jazz.mspx>

to grade their word-processed products. Many online tutorials are available for teaching various software packages, but these may not always be accessible to students. Also, younger or less independent learners may not have the ability to use these self-instructional methods and may need teacher-led instruction.

For all of these reasons, teachers who would like to use word processing in classroom lessons may have to introduce their students to word processing and show them the features and uses of the software. Table 5 shows a recommended strategy to introduce word processing to students in elementary and middle grades. Note that some features and steps are labeled “optional.” Teachers may choose to introduce these on an “as-needed” basis or only with older, more experienced students.

## USING SPREADSHEET SOFTWARE IN TEACHING AND LEARNING

Spreadsheets are programs designed to organize and manipulate numerical data. The term spreadsheet comes from the pre-computer word for an accountant’s ledger: a book

for keeping records of numerical information such as budgets and cash flow. Unlike the term word processing, which refers only to the computer software or program, the term spreadsheet can refer either to the program itself or to the product it produces. Spreadsheet products are sometimes also called **worksheets**. The information in a spreadsheet is stored in rows and columns. Each row–column position is called a **cell** and may contain numerical values, words or character data, and **formulas** or calculation commands.

A spreadsheet helps users manage numbers in the same way that word processing helps them manage words. Spreadsheet software was the earliest application software available for microcomputers. Some people credit spreadsheets with starting the microcomputer revolution, since the availability of the first spreadsheet software, *Visicalc*, motivated many people to buy a microcomputer. Spreadsheet features are listed in Table 6.

## The Impact of Spreadsheets in Education

Like word processing, spreadsheets have seen widespread adoption throughout education. This section gives the reasons for this tool’s popularity and summarizes both the research on using this software and an issue that may affect its integration.

**Why teachers use spreadsheets.** Spreadsheet programs are in widespread use in classrooms at all levels of education. Teachers use them primarily to keep budgets and gradebooks and to help teach mathematical topics. Spreadsheets offer teachers and students several unique benefits:

- » **Save time**—Spreadsheets save valuable time by allowing teachers and students to complete essential calculations quickly. They save time not only by making initial calculations faster and more accurate, but their automatic recalculation features also make it easy to update products such as grades and budgets. Entries also can be changed, added, or deleted easily, with formulas that automatically recalculate final grades.
- » **Organize displays of information**—Although spreadsheet programs are intended for numerical data, their capability to store information in columns makes them ideal tools for designing informational charts, such as schedules and attendance lists, that may contain few numbers and no calculations at all.
- » **Support asking “what if” questions**—Spreadsheets help people visualize the impact of changes in numbers. Since values are automatically recalculated when changes are made in a worksheet, a user can play with numbers and immediately see the result. This capability makes it feasible to pose “what if” questions and to answer them quickly and easily.

**TABLE 5** Tips on Teaching Students How to Do Word Processing[Also see links to Word tutorials at <http://www.internet4classrooms.com/on-line.htm>]

Suggested Steps	Tasks Under Each Step
<p><b>Step 1</b>—Prepare for teaching.</p>	<p><b>Arrange for:</b></p> <ul style="list-style-type: none"> <li>• A big screen or projection system</li> <li>• A disc or flash drive for each student</li> <li>• Copying sample file(s) onto student media</li> <li>• One computer per student</li> <li>• Alternative keyboards or other adaptive devices for students with disabilities</li> </ul> <p><b>Create or obtain:</b></p> <ul style="list-style-type: none"> <li>• Handouts or wall posters on word processing features and common errors</li> </ul>
<p><b>Step 2</b>—Demonstrate the basics.</p>	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Load a disc into a computer disc drive (if needed)</li> <li>• Open a file</li> <li>• Move around in a document using the cursor and scroll bars</li> <li>• Add and delete text; undo changes</li> <li>• Name, save, and close document</li> </ul> <p><b>Point out common errors:</b></p> <ul style="list-style-type: none"> <li>• Forgetting to move cursor before typing</li> <li>• Forgetting about automatic wraparound (pressing Enter or Return at end of lines)</li> <li>• “Losing” part of document on the screen by scrolling up or down</li> <li>• Forgetting to save all changes before closing a file</li> </ul>
<p><b>Step 3</b>—Assign individual practice.</p>	<p><b>Give students a sample word processing file and have them:</b></p> <ul style="list-style-type: none"> <li>• Open the file</li> <li>• Do a list of changes to the file (e.g., inserting spaces, deleting lines, undoing changes)</li> <li>• Name, save, and close document</li> </ul>
<p><b>Step 4</b>—Demonstrate formatting features.</p>	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Change fonts, styles, and alignment</li> <li>• Add clip art</li> <li>• Spell-check the document</li> <li>• Print the document</li> <li>• <b>Optional:</b> Search and replace procedures</li> <li>• <b>Optional:</b> Add bullets and numbering</li> </ul> <p><b>Point out common errors:</b></p> <ul style="list-style-type: none"> <li>• Inserting too many spaces at top or bottom of document (by pressing Enter or Return)</li> <li>• Unexpected errors from Search and Replace feature (failing to predict results)</li> </ul>
<p><b>Step 5</b>—Assign more individual practice.</p>	<p><b>Have students open their sample word processing file from Step 3 and do the following:</b></p> <ul style="list-style-type: none"> <li>• Change fonts, styles, and alignment</li> <li>• Add clip art</li> <li>• Spell-check the document</li> <li>• Print the document</li> <li>• <b>Optional:</b> Search and replace text</li> <li>• <b>Optional:</b> Add bullets and numbering</li> </ul>
<p><b>Step 6</b>—Demonstrate procedures with new files.</p>	<p><b>Show students how to:</b></p> <ul style="list-style-type: none"> <li>• Open a new file</li> <li>• Name and save under different names (Save vs. Save As)</li> <li>• <b>Optional:</b> Set up a new document (e.g., set margins and line spacing)</li> <li>• <b>Optional:</b> Do headers, footers, and pagination</li> </ul>
<p><b>Step 7</b>—Assign more individual practice.</p>	<p><b>Do the following:</b></p> <ul style="list-style-type: none"> <li>• Assign a product for them to copy (for younger students) or create (for older students)</li> <li>• Monitor students as they work and give individual help as needed</li> </ul>



**TABLE 6 A Summary of Spreadsheet Features**

Feature Categories/ General Benefits	Spreadsheet Features	Description of Features
<b>Basic features</b> make it easier to display and manipulate budget, grade, or survey data; and do mathematics problem solving.	Line up information in rows and columns.	Row-column format makes numerical and other information easier to read and digest at a glance.
	Do basic calculations.	Use formulas in cells to do: <ul style="list-style-type: none"> <li>• Basic arithmetic functions: adding, subtracting, multiplying, dividing</li> <li>• Weighted averages by combining these functions</li> </ul>
	Do complex calculations.	Use formulas in cells to do: <ul style="list-style-type: none"> <li>• Mathematical functions such as logarithms and roots</li> <li>• Statistical functions such as sums and averages</li> <li>• Trigonometric functions such as sines and tangents</li> <li>• Logical functions such as Boolean comparisons</li> <li>• Financial functions such as periodic payments and rates</li> <li>• Special-purpose functions such as looking up and comparing data entries with other information (e.g., counting the number of grades above a certain number).</li> </ul>
	Do automatic recalculation.	When a number in one cell changes (e.g., a grade), a spreadsheet formula automatically updates all calculations related to that number (e.g., an average grade).
	Copy cells.	Numbers, formulas, or other information in cells can be copied and pasted to any other cells.
	Sort data.	Data can be organized alphabetically or numerically.
	Search and replace.	One command allows all occurrences of a specified word, phrase, number, or formula to be changed.
<b>Formatting features</b>	Alignment.	Centers or right- or left-justifies cell entries.
	Changes styles/appearance.	Allows: <ul style="list-style-type: none"> <li>• A variety of fonts, sizes, font colors, and type styles in the same document</li> <li>• Cells and graphics to be filled with color or degrees of shading</li> </ul>
	Insert automatic headers, footers, and pagination.	Allows text to be automatically placed at the top (header) or bottom (footer) of each page in a worksheet with or without page numbering (pagination).
<b>Graphics/interactive features</b> allow spreadsheet data to be shown in more visual formats.	Charting.	Creates charts and graphs automatically from spreadsheet data.
	Insert graphics or movies.	Clip art or other still or moving images can be pasted into cells to illustrate concepts or to change document appearance.
	Insert drawn figures.	Allows inserting shapes, callouts, and other figures to enhance worksheet appearance.
<b>Web features</b> allow teachers and students to connect documents with Internet resources and create web page announcements, reports, and projects.	Insert "live" URLs.	Allows person using the spreadsheet to click on text and go automatically to a website. ( <i>Note: Web browser must be active.</i> )
	Save as web pages.	Allows worksheets to be displayed online.
<b>Support features</b> make using the program easier and more flexible.	Read and save to other formats.	Spreadsheet can: <ul style="list-style-type: none"> <li>• Read and use other data files such as those produced by Statistical Packages for the Social Sciences (SPSS) software</li> <li>• Save documents in formats (e.g., tab-delimited) for use in SPSS or other programs</li> </ul>
	Use templates.	Users can easily adapt preformatted models of worksheets (e.g., budgets, checkbooks, and gradekeepers) to their own needs.



Spreadsheets can be a powerful instructional tool to illustrate many kinds of math and business concepts.

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- » **Increase motivation to work with mathematics**—Many teachers feel that spreadsheets make working with numbers more fun. Students sometimes perceive mathematical concepts as dry and boring; spreadsheets can make these concepts so graphic that students express real delight with seeing how they work. Goldberg and Waxman (2003) propose that all students could benefit from using spreadsheets to curb a growing trend toward innumeracy and “quantiphobia” (p. 59).

**Research on the impact of spreadsheet use.** Although spreadsheets are widely believed to help students visualize numerical concepts better than other, nondynamic tools, few studies have attempted to capture their comparative impact on achievement. Studies show, however, that spreadsheets can be useful tools for teaching concepts in many areas, including probability (Beigie, 2010), meteorology (Krall, 2010), business topics (McDermott, 2010), and physics (Benacka, 2010). The literature contains numerous testimonials by teachers who have used spreadsheets

successfully in teaching topics ranging from mathematics to social studies. Wu (2007) found that spreadsheet templates helped students better understand the concepts underlying statistical graphs.

**Issues in using spreadsheets.** Though spreadsheets have a reputation in education for utility and versatility in teaching, they still present more of a problem for many students than do tools such as word processing. Teachers who would employ this versatile software must first address students’ tendency to fear mathematics. They are not afraid to process words, but processing numbers is quite another matter. Teachers usually have to allow time for students to become comfortable with the software and discover that it is an aid to them, rather than a further challenge to their math ability.

## Spreadsheets in the Classroom: Productivity and Teaching Strategies

Spreadsheets offer benefits for both productivity and teaching practices. An overview of both these strategies is given here.

**Productivity strategies.** Teachers can use spreadsheets to help them prepare classroom materials and complete calculations that they would otherwise have to do by hand or with a calculator. The most common uses of spreadsheets are for keeping club and classroom budgets, preparing performance checklists, and keeping gradebooks.

**Instructional integration strategies for spreadsheets.** Teachers can use spreadsheets in many ways to enhance learning. The literature, in fact, reflects an increasing variety of applications. Although their teaching role focuses primarily on mathematics lessons, spreadsheets have also effectively supported instruction in science, social studies, and even language arts. Lewis (2001) offers 40 lessons to help teach various curriculum topics in grades K–8. Current spreadsheet integration strategies include the following:

- » **Making possible visual teaching demonstrations**—Whenever concepts involving numbers can be clarified by concrete representation, spreadsheets contribute to effective teaching demonstrations. Spreadsheets offer an efficient way of demonstrating numerical concepts such as multiplication and percentages and numerical applications, such as the concept of electoral votes versus popular votes. A worksheet can make a picture out of abstract concepts and provide a graphic illustration of what the teacher is trying to communicate. (See Technology Integration Example 3.)
- » **Supporting student products**—Students can use spreadsheets to create neat timelines, charts, and graphs, as well as products that require them to store and calculate numbers. Creating graphic displays of data in a

**TECHNOLOGY INTEGRATION EXAMPLE 3****SPREADSHEET SOFTWARE**

**TITLE:** How the Electoral College Works—A Visual Demonstration

**CONTENT AREA/TOPIC:** Civics, elections

**GRADE LEVEL:** 9

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subject: Government & Civics; Critical Thinking and Problem Solving: Use systems thinking; ICT: Apply technology effectively

**DESCRIPTION:** After the class holds a mock election and assigns electoral votes to each class in the school based on enrollment numbers, the teacher creates a spreadsheet to match the list of classes and their popular and electoral votes. Students enter data on election results, and the teacher displays the spreadsheet on a large monitor so the whole class can see the results as they are entered. Through this activity, students are able to see that if a very few of the popular votes in key areas are changed, the results of the election would be reversed. The class discusses these results as well as the possibility that a candidate could win the popular vote and lose the electoral vote.

**Source:** Based on a concept from the Getting into the Electoral College lesson at the NCTM Illuminations site: <http://illuminations.nctm.org>

spreadsheet program can save time, particularly when changes or corrections are made to the data.

- » **Supporting mathematical problem solving**—Spreadsheets take over the task of doing arithmetic functions so that students can focus on higher level concepts. By answering “what if” questions in a highly graphic format, spreadsheets help teachers encourage logical thinking, develop organizational skills, and promote problem solving.
- » **Storing and allowing analysis of data**—Whenever students must keep track of data from classroom experiments or online surveys, spreadsheets help organize these data and allow students to perform required descriptive statistical analyses on them. (See Technology Integration Example 4.)
- » **Projecting grades**—Students can be taught to use spreadsheets to keep track of their own grades. They

**TECHNOLOGY INTEGRATION EXAMPLE 4****SPREADSHEET SOFTWARE**

**TITLE:** Comparing the Weather in Two Locations

**CONTENT AREA/TOPIC:** Science, weather

**GRADE LEVEL:** 8

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subject: Science; Critical Thinking and Problem Solving: Reason effectively; Information Literacy: Use and manage information

**DESCRIPTION:** Students work in small groups to gather weather data from NOAA’s National Weather Service website (<http://www.weather.gov/forecasts/graphical/sectors>) on two cities the teacher assigns them. They enter the data on a spreadsheet and do calculations to determine temperature and rainfall averages for given periods of time. They compare the two cities’ weather patterns and analyze them to determine reasons for the differences they find. Finally, they report on their findings to the class.

**Source:** Based on a concept in a lesson plan at the Hotchalk website: <http://www.lessonplanspage.com/ScienceCIMDComparingWeatherPatternsOfTwoCitiesTechnologyProject8.htm>

can do their own “what if” questions to see what scores they need to make on their assignments to achieve desired class grades. This simple activity can play an important role in encouraging students to take responsibility for setting goals and achieving them.

**Teaching Spreadsheet Skills: Recommended Skills and Activities**

Just as with word processing, students new to spreadsheets must have time to develop skills in using the software before teachers can begin to grade their work. Some lessons require students to know only the most basic operations, as shown in Step 2 of Table 7. Other activities require students to create their own spreadsheets and formulas, as shown in Step 4. In the latter case, if students are not able to use the online tutorials that are available for teaching spreadsheet software, teachers can use the strategies outlined in Table 7. Even when teaching these advanced concepts, teachers may choose to introduce more complex functions and features on an as-needed basis, depending on the needs of the lesson.

**TABLE 7** Tips on Teaching Spreadsheets[Also see links to spreadsheet tutorials at: <http://www.internet4classrooms.com/on-line.htm>]

Suggested Steps	Tasks Under Each Step
<p><b>Step 1</b>—Prepare for teaching.</p>	<p><b>Arrange for:</b></p> <ul style="list-style-type: none"> <li>• A big screen or projection system</li> <li>• A disc or flash drive for each student</li> <li>• Copying sample file(s) onto student media</li> <li>• One computer per student</li> <li>• Alternative keyboards or other adaptive devices for students with disabilities</li> </ul> <p><b>Create or obtain:</b></p> <ul style="list-style-type: none"> <li>• Handouts or wall posters on spreadsheet features and common errors&gt;</li> </ul>
<p><b>Step 2</b>—Demonstrate the basics.</p>	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Open a spreadsheet file from a disc or flash drive</li> <li>• Select a worksheet to work on in the file by clicking a tab at the bottom</li> <li>• Select any given cell location by row-column position.</li> </ul> <p><b>Then demonstrate:</b></p> <ul style="list-style-type: none"> <li>• Spreadsheet “magic”: Show how it recalculates automatically when a number is changed</li> </ul> <p><b>Finally, show how to:</b></p> <ul style="list-style-type: none"> <li>• Enter new information into a cell</li> <li>• Format given cells for appearance and as various kinds of numbers</li> <li>• Change column width</li> <li>• Copy information in a cell down the column or across a row</li> </ul> <p><b>Point out a common error:</b></p> <ul style="list-style-type: none"> <li>• Forgetting to highlight cells to be formatted before selecting a format option</li> </ul>
<p><b>Step 3</b>—Assign individual practice.</p>	<p><b>Give students a sample spreadsheet file on disc and have them:</b></p> <ul style="list-style-type: none"> <li>• Insert the disc and open the file</li> <li>• Do a list of changes to the file (e.g., insert new data, copy down a column or across a row, format cells)</li> <li>• Name, save, and close the document</li> </ul>
<p><b>Step 4</b>—Demonstrate formatting features.</p>	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Create a formula to add numbers in a column</li> <li>• Copy a formula across the row to add numbers in other columns</li> <li>• <b>Optional:</b> Functions such as SUM and AVERAGE</li> <li>• <b>Optional:</b> Charting functions</li> <li>• <b>Optional:</b> Adding graphics and URLs</li> </ul> <p><b>Point out common errors with formulas:</b></p> <ul style="list-style-type: none"> <li>• Forgetting to place the cursor in the cell where you want the formula</li> <li>• Pressing the Right Arrow key (instead of the Return or Enter Key) to leave the cell while creating a formula (Show that this action adds something to the formula, rather than exiting the cell.)</li> <li>• Including the formula cell itself in the formula’s calculation (i.e., circular reference error)</li> </ul>
<p><b>Step 5</b>—Assign more individual practice.</p>	<p><b>Have students open their sample spreadsheet file from Step 3 and do the following:</b></p> <ul style="list-style-type: none"> <li>• Enter and format various new formulas</li> <li>• <b>Optional:</b> Create a chart based on the data</li> <li>• <b>Optional:</b> Add a graphic and/or a URL</li> <li>• Monitor students as they work, and give individual help as needed</li> </ul>

## USING PRESENTATION SOFTWARE IN TEACHING AND LEARNING

**Presentation software** is designed to display information, including text, images, audio, and video, in a slideshow format. It took the place of photo slides presented in a slide projector and, like the technology it replaced, was originally designed to accompany and support marketing presentations and business training and reports. But like word processing and spreadsheet software, it quickly made the transition from business to education and home use. Though Microsoft *PowerPoint* was not the first such software, and though there are many other packages available for sale and as open-source options, the name “PowerPoint” is often used interchangeably with presentation software, much as the brand name Kleenex® is often used instead of “facial issue.”

Slides or frames created in this software are usually presented in the order in which they appear in the slideshow product. However, recently added features allow hypermedia capabilities, permitting the display of frames in any order by clicking on links or “buttons.” Since those capabilities are best discussed with other hypermedia software, this chapter will focus only on the design and use of the set-sequence presentations. However, all presentation software features are listed in Table 8.

### The Impact of Presentation Software in Education

**Why teachers use presentation software.** Though presentation software is generally used in the same way in education as it is in business, to support speakers (teachers and students) as they present information to listeners, it has evolved additional uses in education that make it a more complex, multi-purpose classroom tool. Current uses are described later in this chapter. Presentation software offers educators the following benefits:

- » **Helps organize thinking about a topic**—When teachers or students create a presentation with this software, it helps them think through what they will say and in what order they should present information. Though using presentation software does not assure an organized, coherent talk, its emphasis on sequencing and breaking information into component parts can promote a more organized approach. Use of presentation software can allow a teacher to illustrate and provide students with practice in information organization skills.
- » **Enhances the impact of spoken information**—When a presentation product is well-designed, it supports and supplements what the speaker says, using

graphics and multimedia to give illustrations and drive home points with images and sound.

- » **Allows collaboration on presentations**—Working together on presentations of project work or research results gives students important practice in collaborative skills. It also allows students to contribute in a variety of ways to the product, rather than just in writing; for example, some may focus on text message design and some on selecting and creating appropriate graphics.

**Research on the instructional uses of presentation software.** This software is a much-studied technology, and researchers have looked at its impact on both educational processes and outcomes. In their review of research on *PowerPoint* uses, Craig and Amernic (2006) analyzed its effects on learning and its impact on classroom dynamics. They found little evidence of any consistent impact on better achievement, but did note strong, positive student reactions to presentation-enhanced instruction. However, they felt that since most of the studies they reviewed were in the early days of this technology, these perceptions could be the result of a novelty effect. They also found a common perception that presentation software had observable effects on classroom dynamics, tending to focus attention on the teacher and discourage student contributions. Craig and Amernic advocate that teachers become more aware of the way they are using presentation software. The emphasis should be on making presentations more dynamic and engaging to students.

Several studies have looked at the impact on exam grades and attendance of making *PowerPoint* slides available to students outside the classroom (e.g., Babb & Ross, 2009; Bowman, 2009; Cramer, Collins, Snider, & Fawcett, 2007). Findings usually show no impact on achievement and inconsistent impact on attendance. Hardin (2007) studied the impact of *PowerPoint* on student learning, satisfaction, and engagement and found that impact depended more on instructor variables than on whether *PowerPoint* was used. These results seem to confirm that presentation slides provide yet another avenue to enhance student learning, but their impact depends largely on how teachers use them and how much time students spend with the material.

**Issues in using presentation software.** Use of presentation software has produced strong reactions by several observers. Issues related to presentation software use include:

- » **Impact of presentation software on information presented**—Tufte (2003) is an acknowledged critic, famously saying that “Power corrupts; PowerPoint corrupts absolutely.” He is among those who feel that

**TABLE 8 A Summary of Presentation Software Features**

Feature Categories/ General Benefits	Presentation Software Features	Description of Features
<p><b>Basic features</b> allow display of frames of information in a set sequence.</p>	<ul style="list-style-type: none"> <li>• Create a slideshow made of separate frames.</li> </ul>	<ul style="list-style-type: none"> <li>• Frame-by-frame organization breaks up information into logical units that can be presented one at a time.</li> </ul>
	<ul style="list-style-type: none"> <li>• Add frames with various formats.</li> </ul>	<ul style="list-style-type: none"> <li>• Frame styles can be different on each page; styles can range from a blank frame to one with locations marked for where text and graphics should be inserted.</li> </ul>
	<ul style="list-style-type: none"> <li>• Copy and paste slides.</li> </ul>	<ul style="list-style-type: none"> <li>• Slides can be added by duplicating other slides.</li> </ul>
	<ul style="list-style-type: none"> <li>• Add speaker notes to slides.</li> </ul>	<ul style="list-style-type: none"> <li>• Helps users plan what to say as each frame is presented.</li> </ul>
	<ul style="list-style-type: none"> <li>• Search and replace.</li> </ul>	<ul style="list-style-type: none"> <li>• One command allows all occurrences of a specified word or phrase to be changed as specified.</li> </ul>
<p><b>Display features</b> allow various ways to view slideshows.</p>	<ul style="list-style-type: none"> <li>• Display in various ways as single frame.</li> </ul>	<ul style="list-style-type: none"> <li>• Displays a slide that either: allows changes to be made on it before presentation, or a full-screen display during a presentation.</li> </ul>
	<ul style="list-style-type: none"> <li>• Display as storyboard.</li> </ul>	<ul style="list-style-type: none"> <li>• Shows all frames at once for review and/or changing frame sequence.</li> </ul>
<p><b>Formatting features</b> allow variation in text spacing and frame appearance.</p>	<ul style="list-style-type: none"> <li>• Format font size and type.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows text variety to enhance frame appearance.</li> </ul>
	<ul style="list-style-type: none"> <li>• Format background color.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows each frame to have different background color to better highlight information and focus viewers' attention.</li> </ul>
<p><b>Graphics and interactive features</b> make frames have more impact and utility.</p>	<ul style="list-style-type: none"> <li>• Insert images.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows adding: clip art from a library that comes with the software and includes photos and animations; or images from other sources.</li> </ul>
	<ul style="list-style-type: none"> <li>• Insert drawn figures.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows inserting shapes, callouts, lines, or other figures to enhance frame appearance or to help illustrate concepts.</li> </ul>
	<ul style="list-style-type: none"> <li>• Insert movies.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows inserting short videos to supplement slide information from text and images.</li> </ul>
	<ul style="list-style-type: none"> <li>• Insert charts and graphs.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows creation of charts or graphs to insert on frames to illustrate concepts.</li> </ul>
	<ul style="list-style-type: none"> <li>• Insert products created in other software.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows word-processed text or spreadsheet products, including charts and graphs, to be added to frames.</li> </ul>
	<ul style="list-style-type: none"> <li>• Interactive buttons or "hotspots."</li> </ul>	<ul style="list-style-type: none"> <li>• Links can be inserted to allow users to "jump" to other parts of the presentation out of the order in which slides are stored in presentation.</li> </ul>
<p><b>Web features</b> allow teachers and students to connect frames to Internet resources</p>	<ul style="list-style-type: none"> <li>• Insert "live" URLs.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows person displaying the presentation to click on text or images and go automatically to a website. (Note: Web browser must be active.)</li> </ul> <p style="text-align: right;"><i>Continued</i></p>

**TABLE 8 A Summary of Presentation Software Features (continued)**

Feature Categories/ General Benefits	Presentation Software Features	Description of Features
	<ul style="list-style-type: none"> <li>• Save presentations as web pages.</li> </ul>	<ul style="list-style-type: none"> <li>• Allows presentations to be accessed and displayed online.</li> </ul>
<p><b>Support features</b> make using the program easier and more flexible.</p>	<ul style="list-style-type: none"> <li>• Use templates.</li> </ul>	<ul style="list-style-type: none"> <li>• Users can add information to already formatted files that come with themed graphics already on each slide.</li> </ul>
	<ul style="list-style-type: none"> <li>• Save to other formats.</li> </ul>	<ul style="list-style-type: none"> <li>• Presentations can be saved as PDFs to allow use as documents or as read-only presentations for sharing with others.</li> </ul>
	<ul style="list-style-type: none"> <li>• Print as handouts.</li> </ul>	<ul style="list-style-type: none"> <li>• Presentations can be printed with varying numbers of slides per page and given to listeners for following and note-taking.</li> </ul>
	<ul style="list-style-type: none"> <li>• Use timed presentations.</li> </ul>	<ul style="list-style-type: none"> <li>• Presentations can be set up to display frames automatically using timing settings or to play narration or music during the show.</li> </ul>

presentation software makes people focus on the slides, rather than the message, saying that “rather than supplementing a presentation, [PowerPoint] has become a substitute for it” (p. 3). (See Hot Topic Debate.)

- » **Impact of presentation software on teaching style**—There are also complaints about the effects that using slide-based software has on teaching style and impact. Young (2009) cites a British study that reported students perceived use of *PowerPoint*-based lectures among the most boring they experience. Adams (2006) says that using *PowerPoint* “invites and seduces educators to reshape knowledge in particular ways and supports a cognitive and pedagogical style inconsistent with both the development of higher analytical thinking skills and the acquisition of rich narrative and interpretive understanding” (p. 389). On the other hand, Elliott and Gordon (2006) said that proper use of presentation software can support constructivist activities and promote “critical thinking, active learning, deep understanding, and engaging discussion” (p. 34).

Criticisms of this tool seem best addressed by teachers becoming more aware of the most effective uses of presentation software. Klemm (2007) offers several tips for avoiding uses of presentation software that make them a “trap for bad teaching” (p. 121). These include showing only a few slides at a time before having students apply the information, having some slides with no text (images or diagrams only), moving around the room while showing slides, taking the last slide off the screen when moving on to student work, and not giving out hard copies of slides.

## Presentation Software in the Classroom: Productivity and Teaching Strategies

The benefits that presentation software offers are primarily to teaching practices. This section offers an overview of these strategies, as well as how to make time spent with presentations more productive.

**Productivity strategies.** Since presentation software is designed specifically for presenting information, it has no real productivity applications. However, *PowerPoint* impact can be maximized and time spent watching such presentations can be made more productive by following the design and use rules listed in Figure 1, as well as Klemm’s (2007) guidelines.

**Instructional integration strategies for presentation software.** Since presentation software can support instruction in any content area, the literature reflects many examples of effective uses. Current integration strategies for presentation software include the following:

- » **Presentation of information summaries**—By far the most popular use of these tools is for supporting and strengthening classroom presentations. Teachers use them to focus student attention and guide note-taking.
- » **Demonstrations of materials for discussion**—In this strategy, the teacher displays a complex diagram such as an electrical circuit or light spectrum, or a series of examples such as works of art, types of animals, or instruments in an orchestra. This is an ideal way to focus

## IS POWERPOINT REALLY EVIL?

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 a 2003 article, "PowerPoint is Evil" (<http://www.wired.com/wired/archive/11.09/ppt2.html>),

Edward Tufte says that "the PowerPoint style routinely disrupts, dominates, and trivializes content. Thus PowerPoint presentations too often resemble a school play—very loud, very slow, and very simple." The *New York Times* published an article entitled "We Have Met the Enemy and He Is PowerPoint" (<http://www.nytimes.com/2010/04/27/world/27powerpoint.html>). What characteristics serve to make presentations with PowerPoint or other software less than helpful? What guidelines can you cite to make sure such presentations are helpful?

### FIGURE 1 A Summary of Presentation Software Design and Use Guidelines

All of the following are qualities that can greatly enhance readability, audience engagement, and/or communication of content during a PowerPoint or Keynote presentation.

1. **Use large type**—Use at least a 32-point font; use a larger type size if the audience is large and a long distance away from the presenter. Smaller type (no less than a 20-point font) may be used to provide citations, references, and sources, which are typically positioned in the lower-left or -right corner of the appropriate slide.
2. **Contrast the text and background colors**—The audience cannot see text that is too similar in hue to the background on which it appears. Use text with high contrast to the background (e.g., dark text on light-colored backgrounds, white text on dark-colored backgrounds).
3. **Minimize the amount of text on each frame**—Use text to focus attention on main points, not to present large amounts of information. Summarize ideas in brief phrases and make sure that you, not the projection screen, are the focus of the presentation. In other words, use the presentation to enhance, strengthen, and expand upon points that are outlined briefly on each frame.
4. **Keep frames simple**—Frame designs should be simple, clear, and free of distractions. Too many items on one frame can interfere with reading, especially if some items are in motion. In addition, try to employ photographs and images in place of lengthy text when describing a context or event. Finally, try to minimize the number of bullet points (not to exceed three to five points) on each individual slide.
5. **Avoid using too many "fancy" fonts**—Many fonts are unreadable when projected on a screen. Use a plain sans serif (straight lines with no "hands" and "feet") font for titles and a plain serif font for other text. Avoid using more than three different fonts throughout the presentation to maintain consistency of headings, body text, and pull-out text.
6. **Avoid using gratuitous graphics and clip art**—Graphics interfere with communication when used solely for decoration. Use graphics to help communicate and expand upon the content, not for the sake of using graphics alone.
7. **Avoid using gratuitous sounds**—Sounds interfere with communication when used solely for effect. They should always help communicate the content and not be used as a transition effect.
8. **Use graphics, not just text**—Well-chosen graphics can help communicate messages. Text alone does not make the best use of the capabilities of presentation software. However, with the ever-increasing ease of finding and downloading photographs and images from online sources, it is important that you encourage students to document where images come from and to cite the proper sources in their presentations.
9. **Present in a dark room**—Frames can fade away if the room is too bright. Make sure to cover windows and turn off lights during a presentation.
10. **Avoid reading text aloud**—Do not read what the audience can read for themselves. Use text to guide the main points of discussion. This will help you focus on presenting to the audience as opposed to speaking at the screen. Remember, you—not the PowerPoint—are doing the presenting.



## TECHNOLOGY INTEGRATION EXAMPLE 5

### PRESENTATION SOFTWARE

**TITLE:** Cave Drawings

**CONTENT AREA/TOPIC:** Social studies (history), art

**GRADE LEVEL:** 6–8

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration

**21ST CENTURY SKILLS:** Core subjects: History and Arts; Creativity and Innovation—Think creatively; Critical Thinking and Problem Solving—Reason effectively; Communication and Collaboration—Communicate clearly

**DESCRIPTION:** Students learn about prehistoric man and the messages left in caves from that time. The teacher displays a presentation with example drawings. Students discuss the messages being communicated in pictures. Then, they try their hand at “drawing messages.” The lesson wraps up with a discussion on similarities between cave drawings and television, magazines, or newspapers. Students can also create a newspaper advertisement using only pictures and/or symbols, then see if others can guess the topic of the advertisement.

**Source:** Based on a concept in Cave Drawing lesson plan at Technology website: [http://www.teach-nology.com/teachers/lesson\\_plans/history/cavedrawings68.html](http://www.teach-nology.com/teachers/lesson_plans/history/cavedrawings68.html)



The most powerful strategy for integrating presentation software is for students to create individual or small-group presentations to document and display results of their research and/or to practice making persuasive presentations.

Photo by W. Wiencke.

student attention while explaining important concepts or pointing out essential features.

- » **Presentation of illustrative problems and solutions**—Projection with presentation software is useful when the whole class needs to see example problems and how to solve them (e.g., in mathematics or chemistry) prior to doing their own problems.
- » **Practice screens**—Many teachers set up presentations of spelling or vocabulary words or objects to identify (e.g., lab equipment, famous names or places) to run automatically in the classroom, knowing that students’ eyes are drawn to the moving slides.
- » **Assessment screens**—When teachers need students to identify pictures of items (e.g., lab equipment, famous people), presentation screens can enable visual assessment strategies.
- » **Brief tutorials**—Teachers can create presentation software reviews of simple concepts (e.g., grammar rules)

## TECHNOLOGY INTEGRATION EXAMPLE 6

### PRESENTATION SOFTWARE

**TITLE:** Here’s My Hero

**CONTENT AREA/TOPIC:** Language arts and technology

**GRADE LEVELS:** 4–5

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Language arts; Communication and Collaboration—Communicate clearly; Information Literacy—Apply technology effectively

**DESCRIPTION:** Students identify a historical figure they regard as a hero and make a presentation about him/her to share with the class. They gather images and data from the Internet to add to their slides. They use *PowerPoint* features to format their slides, create a timeline of significant events in their hero’s life (organizational chart), and insert a table comparing themselves to their hero. Before making their presentations, they learn how to organize speaker notes for their slides and re-arrange slides for maximum impact during the presentation.

**Source:** Based on a concept in a lesson plan at the TechnoKids website: <http://www.technokids.com/computer-curriculum/junior/powerpoint-lesson-plans-technohero.aspx>

or “how-to” procedures (e.g., a lab procedure, computer software demonstration) so that students can review these on their own to make up work or to prepare for tests.

- » **Book reports**—Instead of presenting book reports verbally or as written summaries, it is becoming increasingly common for students to report on their reading using presentation slideshows. Teachers often design a standard format or template, and students fill in the required information and add their own illustrations.
- » **Student presentations of project work**—The most powerful strategy for integrating presentation software is for students to create individual or small-group presentations to document and display results of research they have done and/or to practice making persuasive presentations. Having learners become the designers and experts of content, in the end presenting their work to the class, can serve as a powerful technology integration lesson for any domain of learning. Franklin (2008) described a lesson that has each student choose a chemical element to learn about and create a *PowerPoint* presentation to teach others. Henson (2008) used a similar strategy to have students research animal behavior and present their findings. Lindroth (2007) described using a *PowerPoint* slide show that students create to

display what they learned in a multicultural unit, and then use it as background scenery for a school play. McVee, Bailey, and Shanahan (2008) told of students using *PowerPoint* to help display their interpretation of poems. Schwebach (2008) describes how students used *PowerPoint* to present their capstone research projects. (See Technology Integration Example 6.)

## Teaching Presentation Software Skills: Recommended Skills and Activities

If students are to develop their own presentations, as is required in some of the integration strategies described in this chapter, they must have time to learn the software before their products are graded. Ideally, they will have time to play with the software and explore its capabilities. However, direct instruction may be a more efficient use of classroom time. If students are not able to use the online tutorials that provide direct instruction in how to use presentation software (see link in Table 9), teachers can use the strategies outlined in Table 9 to teach this software. Teachers may decide to teach other functions and features of presentation software gradually over time, depending on the needs of the lessons.

**TABLE 9** Tips on Teaching Students How to Create Presentations

(Also see links to *PowerPoint* tutorials at: <http://www.internet4classrooms.com/on-line.htm>)

Suggested Steps	Tasks Under Each Step
<b>Step 1</b> —Prepare for teaching.	<p><b>Arrange for:</b></p> <ul style="list-style-type: none"> <li>• A big screen or projection system</li> <li>• A disc or flash drive for each student</li> <li>• Copying sample file(s) onto student media</li> <li>• One computer per student</li> <li>• Alternative keyboards or other adaptive devices for students with disabilities</li> </ul> <p><b>Create or obtain:</b></p> <ul style="list-style-type: none"> <li>• Handouts or wall posters on presentation software features and common errors</li> </ul>
<b>Step 2</b> —Demonstrate the basics using a sample prepared presentation.	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Open a sample slideshow file from a disc or other location</li> <li>• Page through the frames using the slide-bar and thumbnail views</li> <li>• See all frames at once in slide sorter format</li> <li>• Get from one view to another using menus or icons at bottom of screen</li> </ul> <p><b>Then demonstrate:</b></p> <ul style="list-style-type: none"> <li>• How to display the slideshow as a presentation</li> </ul> <p><b>Finally, show how to:</b></p> <ul style="list-style-type: none"> <li>• Create an additional slide at any location in the presentation</li> <li>• Select a slide format from those available</li> <li>• Add text to the slide and format it</li> <li>• Add clip art from a library</li> <li>• Add an image from a hard drive or a flash drive</li> </ul>

*Continued*

**TABLE 9** Tips on Teaching Students How to Create Presentations (continued)

Suggested Steps	Tasks Under Each Step
<b>Step 3</b> —Assign individual or small-group practice.	<p><b>Give students a sample presentation file and have them:</b></p> <ul style="list-style-type: none"> <li>• Open the file</li> <li>• Do a list of changes to the file (e.g., add new slides, insert text and images)</li> <li>• Name, save, and close the document</li> </ul>
<b>Step 4</b> —Demonstrate advanced features.	<p><b>Using a big screen or projection system, show how to:</b></p> <ul style="list-style-type: none"> <li>• Add transitions to slides</li> <li>• Optional: Insert shapes and lines</li> <li>• <b>Optional:</b> Add WordArt or charts</li> <li>• <b>Optional:</b> Do notes</li> <li>• <b>Optional:</b> Do headers and footers for handouts</li> <li>• <b>Optional:</b> Print handouts</li> </ul>
<b>Step 5</b> —Assign more practice.	<p><b>Do the following:</b></p> <ul style="list-style-type: none"> <li>• Assign a product for them to copy or experiment with (for young students) or create (for older students)</li> <li>• Monitor students as they work and give individual help where needed</li> </ul>



## SUMMARY

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

**1. Overview of the “Basic Three”**—Three software tools that are usually part of the basic suite of programs most people buy are: word processing, spreadsheet, and presentation software.

- » Benefits of these programs include: improved productivity, appearance, and accuracy, and more support for interaction and collaboration.
- » Developments since these products were first made available include: Web-based collaboration tools, open-source software, mobile tools, web-enabled features, better file-exchange compatibility, and software suites and integrated packages.

**2. Word processing is a software tool that allows people to produce typed documents on a computer screen.**

- » Word processing benefits include: Saving time, improving document appearance, allowing easy exchange of work, and allowing collaboration.
- » Word processing issues include: Questions about the age students should start word processing, necessity to teach keyboarding skills, effects of word processing on handwriting, impact of word processing on assessment, and problems with inadvertent errors.
- » Word processing productivity applications include: Creating handouts or other instructional materials, lesson plans and notes, reports, forms, letters to parents or students, flyers, and newsletters.

- » Word processing instructional integration strategies include: Supporting the learning of writing processes; using a dynamic group process approach; assigning individual language, writing, and reading exercises; and encouraging writing through the curriculum.

**3. Spreadsheets are software tools designed to organize and manipulate numerical data.**

- » Spreadsheet benefits include: Saving time, organizing displays of information, and increasing motivation to work with mathematics.
- » Spreadsheet productivity applications include: Keeping club and classroom budgets, preparing performance checklists, and keeping gradebooks.
- » Spreadsheet instructional integration strategies include: Making possible visual teaching demonstrations, supporting student products, supporting mathematical and “what if” problem solving, storing and allowing analysis of data, and projecting grades.

**4. Presentation programs are software tools that are designed to display information, including text, images, audio, and video, in a slideshow format.**

- » Presentation software benefits include: Helping organize thinking about a topic, enhancing the impact of spoken information, and allowing collaboration on presentations.

- » Presentation software issues include: Impact of presentation software on information presented and impact of presentation software on teaching style.
- » Presentation software integration strategies include: Presentation of information summaries, demonstrations of

materials for discussion, presentation of illustrative problems and solutions, practice screens, assessment screens, brief tutorials, book reports, and student presentations of project work.



## 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.** In his *New York Times* blog post, "Ending the Curse of Cursive," John Tierney quoted Vanderbilt professor Steve Graham: "If every young child had a computer to write on, and the keyboards were built for young children, and we provided instruction to help them type fluently, then the need for handwriting would be questionable." Do you agree with Dr. Graham that we should eschew teaching cursive writing in favor of focusing on word processing instruction? What would be the impact of this decision on elementary children and curriculum?

**2.** In her article, "Spreadsheet Issues: Pitfalls, Best Practices, and Practical Tips" (see <http://www.soa.org/library/journals/actuarial-practice-forum/2010/february/apf-2010-02-campbell.pdf>), Campbell cites a number of problems caused by spreadsheet errors. What are the sources of these kinds of errors? How can teachers help students avoid them in spreadsheets they create?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.
- d. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- e. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- f. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- g. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- h. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions that follow it.

*Ms. Ball is a veteran eighth grade social studies teacher who struggles with getting her students to work together in groups. Some of the new state standards in social studies require collaboration skills, but she finds that students dislike working in small groups and resist doing assignments that call for it. She attended a conference presentation on having students work in groups to research a history topic and collaborate on a PowerPoint presentation to present their findings to the class. She thinks the software's slide format might make collaboration both easier to do and more motivational to students, since each of them could work on a part after meeting to agree on how work would be divided. That way, it would be easier for them to do their contribution separately and put it all together in a final product. It would also be easier to see which students didn't do their assigned parts. The conference presenters gave resources to consult on how to teach small-group collaborative skills more effectively. Ms. Ball decided to read the resources and revise her strategies for facilitating group*

work. Also, though she had used PowerPoint software before and felt comfortable with it, she had never taught students how to use it.

- a. Deconstruct Ms. Ball’s Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that Ms. Ball must address to implement this new strategy effectively in her classroom.

pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the types of software tools you learned about in this chapter. The technology should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy:

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need the most appropriate combination of technological,



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.

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# TECHNOLOGY TOOLS FOR 21ST CENTURY TEACHING BEYOND THE BASICS



# TECHNOLOGY TOOLS FOR 21ST CENTURY TEACHING

## BEYOND THE BASICS

We shape our tools and afterwards our tools shape us.

Marshall McLuhan, *Understanding Media: The Extensions of Man* (1964)

### o u t c o m e s

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

1. Analyze how recent developments in software formats and delivery systems have improved the usefulness of each of the six categories of software tools given in the chapter.
2. Develop activities for given materials generator tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.
3. Develop activities for given data collection and analysis tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.
4. Develop activities for given graphics tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.
5. Develop activities for given planning and organizing tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.
6. Develop activities for given research and reference tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.
7. Develop activities for given content-area tools that support teaching and/or learning tasks, use the functions and capabilities of the tool, and serve to make the tasks more efficient and productive.



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### key terms

calculator-based lab (CBL)  
charting/graphing tools  
clickers  
clip art  
cloud computing  
Cloze exercises  
computer adaptive testing (CAT)  
computer-assisted design (CAD)  
computer-assisted testing (CAT)

concept mapping software  
databases  
data mining  
desktop publishing  
electronic gradebook  
electronic storybooks  
field  
fonts  
foreign language dictionaries

forms makers  
Geographic Information System (GIS)  
Global Positioning System (GPS)  
graphic document makers  
graphing calculators  
HTML  
IEP generator  
image editing programs



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# TECHNOLOGY INTEGRATION IN ACTION: SHARING A PASSION FOR POETRY

GRADE LEVEL: Grades 2-5 • CONTENT AREA/TOPIC: Language arts, poetry • LENGTH OF TIME: An hour each day for 6 days

## PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

### Step 1: Determine relative advantage.

Mr. Jarzyniecki is a fifth grade teacher who has great difficulty getting his young students to share his passion for poetry. He tried various teaching approaches, but many students remained indifferent, and few are interested enough to read or write poems after the unit is over. When he taught mathematics activities, he had found that using his interactive whiteboard made it easier to engage students, especially if they played a part in illustrating and practicing concepts. He felt that with the right kinds of activities, he might also engage them in learning about and writing poetry. From a blog for teachers, he learned about some online materials to help teach poetry, some of which could be used with interactive whiteboards and allowed students to publish their work online. After reviewing the materials, he decided to restructure his poetry unit around these activities. He would display the online "poetry engine" on the whiteboard to illustrate several types of poems that kids can write, and it would also allow students some initial practice in writing poems. After more practice in pairs and small groups, each would have to write one poem of each kind,



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with or without the poetry engine, and each would be allowed to publish one poem on the website.

### Step 2: Assess Tech-PACK.

**Content and Pedagogical Domains.** Mr. Jarzyniecki felt he knew a great deal about writing poetry, since he had had good

individualized education program (IEP)  
interactive whiteboard  
interactive whiteboard activity software  
microcomputer-based lab (MBL)  
language translators (machine translation)

Musical Instrument Digital Interface (MIDI)  
morphing  
music editor  
music sequencers  
music synthesizer  
outlining tools  
Portable Document Format (PDF) file

probeware  
puzzle generators  
record  
sans serif typeface  
serif typeface  
SMARTable Interactive Learning Center®  
statistical software packages  
student information systems (SIS)

student response systems  
test generators  
test item banks  
web design software (web page editors)  
webquest  
word atlases  
worksheet generators



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instructors in his undergraduate program and was a poet himself. But after three years of unsuccessful efforts to engage his students in poetry writing, he felt less confident in his ability to motivate young people on this topic. To improve his instructional approaches, he read through a variety of blogs and online materials looking for ideas on how to teach poetry better. After reading these materials and blogging with colleagues who gave him good leads, he felt more confident that the new approach would be much more motivating to students.

**Technology Domain.** Mr. Jarzyniecki was already very adept at using online materials, and the websites he would use presented no technical challenges; they were intuitive and easy to use. Students would do their offline work on word processors, and they had considerable practice with that software. He felt ready to proceed.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

To help him see if students were achieving what he hoped in the poetry unit, Mr. Jarzyniecki created objectives and assessments to

measure students' progress in poetry skills, as well as their attitudes toward poetry. The outcomes, objectives, and assessments were:

- » **Outcome:** Write three different poems reflecting three different poetry genres. **Objective:** After participating in the practice activities, each student writes three poems in correct format, using either a poetry engine or writing on the word processor, and provides an illustration for at least one. **Assessment:** A rubric of criteria and points.
- » **Outcome:** Feel more positively about poetry. **Objective:** At least 80% of students express interest in reading or writing additional poems, as reflected in comments to the teacher or poems they offer. **Assessment:** Teacher observation.

### Step 4: Design integration strategies.

Mr. Jarzyniecki knew that the initial activities would be group-based, followed up by individual ones. He designed the following sequence of activities to be done in one hour each day for one week:

- » **Day 1: Introduce the unit.** Begin by reading two short poems from a book of popular poems for young people (e.g., Shel Silverstein's *Where the Sidewalk Ends*), while displaying on the whiteboard an image for each poem from the book. Ask students to close their eyes while a poem is read; ask if the poem brought an image to mind for any of them. Tell students that they can write, illustrate, and publish poems of their own. Demonstrate the poetry engine on the whiteboard and let students come to the whiteboard and practice generating poems of each genre in front of the class. Tell students they may bring a favorite poem to share with the class the next day, if they like.
- » **Day 2: Allow student practice and sharing.** Ask one or two students to share the poem they found or wrote. Show students the part of the site on which students can publish their work. Tell them that by the end of the week, they will write three poems and select one to publish. Display and discuss the rubrics on

## INTRODUCTION TO OTHER SOFTWARE SUPPORT TOOLS

An ever-increasing number of software tools are available that go beyond what many people think of as the "basic" capabilities of word processing, spreadsheets, and presentation software. These additional materials serve teachers and students in a variety of ways, making possible many kinds of freedom in the classroom. These tools vary greatly in their purposes and the benefits they offer. Since teachers should choose them for the qualities and benefits they bring

to the classroom, rather than simply because they are available, this chapter will focus on unique features and classroom needs each of them can meet. The tools described in this chapter range in importance from nearly essential to "nice to have," and in function from presenting instruction to supporting background tasks that make a classroom run smoothly. Depending on the tool and the needs of the situation, a software support tool can offer the following benefits:

- » Improved efficiency and productivity
- » Improved appearance of product

the whiteboard. Allow students to work in small groups with the three classroom computers using the poetry engine. Other students work on illustrations that can accompany poems, writing other poems, and on reviewing books of popular poetry for young people. Facilitate their work and answers questions, as needed. Ask them to begin thinking about which poem they would like to upload to the site in order to become a published poet. Tell students that some of them may share one of their own poems with the class each day of this week.

- » **Day 3: Continue practice and sharing.** Ask a few students to share the poems they wrote the day before, and remind students they may bring a poem to share with the class the next day. Continue work with the poetry engines and seatwork on illustrations and reading and writing additional poems.
- » **Day 4: Continue practice and sharing.** Ask more students to share their poems by displaying them on the whiteboard and talk about their poetry ideas. Ask students to change or move around words in ways that improve the poems. Encourage them to express their thoughts about poetry and what they like and don't like about it. Remind them that they must select only one poem to publish.
- » **Day 5: Select and publish poems.** Ask more students to share their poems. Allow students to begin publishing their selected poems on the classroom computers, while other students complete work on their poems and illustrations.
- » **Day 6: Complete work.** Ask more students to share their poems. Finish publishing all poems to the site. Give students a handout to give to parents with the website where they may find their child's published poem.
- » **Post-unit activity.** Arrange for a poetry reading event where children get to read aloud their published poems.

### Step 5: Prepare instructional environment.

The first time Mr. Jarzyniecki taught this project, he created the rubric and student and parent handouts, and created a whiteboard file to allow touch-screen use of the poetry engine display. For subsequent times, he had to do the following:

- » Better accuracy and timeliness of information
- » More support for interaction and sharing

## Types of Software Support Tools

This chapter describes six general categories of software support tools. Table 1 provides examples of software products under each of the following categories:

- » **Materials generators**—Help teachers and students produce instructional materials on paper and online.

- » **Prepare for whiteboard displays:** He selected the images to display from the computer and checked to make sure the whiteboard was working with the software file he would use with the poetry engine.
- » **Prepare classroom computers:** He checked each of the classroom computers and made sure the poetry website was in the Favorites list.
- » **Make handout copies:** He made copies of the students' rubric and parent handouts.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

Mr. Jarzyniecki was delighted with the response from his students. All of them completed all three required poems in good shape, and in the weeks following the unit, about 50% of them asked how they could write or read more poems. Though he didn't meet his own criterion of 80% of the students, he felt he was on the right track with this approach. Several parents had contacted either him or his principal expressing their delight with their child's published poems.

### Step 7: Make revisions.

Though the unit generally went smoothly, there was not enough time in the six days for all students to publish their poems, and some students needed more time to complete their work. Also, not all students got to read a poem that was displayed in front of the class. Since these were the most motivational of the activities, Mr. Jarzyniecki decided to schedule a computer lab day to do uploading of poems and allow students to continue reading a poem each day until everyone had a chance.

**Source:** Based on a concept presented in: Scholastic's *Writing with Writers: Poetry* activities and resources.

- » **Data collection and analysis tools**—Help teachers collect and organize information that indicates student progress.
- » **Graphics tools**—Allow manipulation of images to illustrate documents and web pages.
- » **Planning and organizing tools**—Help teachers and students conceptualize, organize, and communicate their ideas.
- » **Research and reference tools**—Let students look up information in electronic versions of encyclopedias, atlases, and dictionaries.
- » **Content-area tools**—Support teaching and learning activities in various content areas.

**TABLE 1** Overview of Software Tool Categories

Tool Category	Example Software Tools	Purposes and Benefits
Materials generators	<ul style="list-style-type: none"> <li>• Desktop publishing software</li> <li>• Web design software</li> <li>• Whiteboard software</li> <li>• Test generators and test item banks</li> <li>• Worksheet and puzzle generators</li> <li>• PDF and forms makers</li> </ul>	Allow creation and use of documents, web pages, tests, and various lessons and exercises
Data collection and analysis tools	<ul style="list-style-type: none"> <li>• Database software</li> <li>• Online survey software</li> <li>• Electronic gradebooks</li> <li>• Statistical packages</li> <li>• Student management systems</li> <li>• Testing systems</li> <li>• Student response systems</li> </ul>	Collect data from students; support decision making; analyze data from experiments and research
Graphics tools	<ul style="list-style-type: none"> <li>• Draw/paint programs</li> <li>• Image editing software</li> <li>• Charting/graphing software</li> </ul>	Create illustrations for use in documents and web pages; create visual data summaries
Planning and organizing tools	<ul style="list-style-type: none"> <li>• Outlining and concept mapping software</li> <li>• Lesson planning software</li> <li>• Calendars, scheduling and time management tools</li> </ul>	Help organize ideas for writing and discussion; help organize, plan, and schedule activities
Research and reference tools	<ul style="list-style-type: none"> <li>• Electronic encyclopedias</li> <li>• Electronic atlases and mapping tools</li> <li>• Electronic dictionaries and thesauruses</li> </ul>	Help students research on assigned topics; assist with writing using correct spelling and word use
Content-area tools	<ul style="list-style-type: none"> <li>• MIDI tools: music editors and synthesizers</li> <li>• CAD systems</li> <li>• Reading tools</li> <li>• MBLs/CBLs</li> <li>• GPS/GIS systems</li> <li>• Online language translators</li> </ul>	Support tasks specific to content areas such as technology education, music, reading, science, math, social studies, and foreign languages

## Recent Developments in Software Support Tools

Although some of these tools have been in existence for many years, they are constantly being updated with new features and capabilities. The following developments have made these tools even more useful in the classroom.

- » **Cell phones and other handheld technologies**—Handheld devices such as iPads and cell phones have made software tools even more portable and accessible to teachers and students, and this more portable format has made software tools even more popular. Schools continue to experiment with how these technologies can be used to enhance educational practice, especially now that many more students have access to them.
- » **Web and cloud availability**—Though some software tools continue to be packaged and sold on discs, many are now available only as downloads from the Internet. Others aim for maximum access with **cloud**

**computing**, which is storage outside ones' own computer on servers that are accessed through the Internet.

- » **Software suites**—Just as word processing, spreadsheets, and presentation software are packaged together as “software suites” in order to combine their capabilities and make them easier to use together, other software tools are also available in packages matched to various needs. For example, if a teacher wanted to do complex print publications, Adobe's *Creative Suite Design Standard* combines high-end desktop publishing software (Adobe *InDesign*) with Adobe *Photoshop* (image editor), Adobe *Illustrator* (drawing software), and Adobe *Acrobat* (portable document software). If the goal was designing full-featured web pages, Adobe's *Creative Suite Web Premium* package would include Adobe *Dreamweaver* and Adobe *Fireworks*. While these highly capable suites are fairly expensive for educators, other software suites (as well as separate software tools) are available as free downloads (see Open-Source Options).

## USING MATERIALS GENERATORS

Materials generators include desktop publishing software, web page editors, whiteboard activity software, test generators and rubric generators, worksheet and puzzle generators, IEP generators, graphic document makers, and PDF and forms makers. A summary of these, with sample

products and classroom uses, is shown in Table 2. Free versions of many of these tools are shown in Open-Source Options.

### Desktop Publishing Software

It is perhaps ironic that one of the most useful and widely used of the technology tools is one that communicates information in a traditional medium: the printed page. By

## Free open source **OPTIONS** for Tool Software Sites

### TYPES

### FREE SOURCES

#### Materials generators

Desktop publishing (see also <http://desktoppublishing.com/open.html>)

*Page Plus Starter Edition*: <http://www.serif.com/desktop-publishing-software>

*Scribus*: <http://www.scribus.net>

*NVu* web design software: <http://www.nvu.com>

Test generator: <http://mytest.vocabtest.com>

Rubric maker—*RubiStar* (use program or pre-made rubrics): <http://rubistar.4teachers.org>

Puzzle maker: <http://www.discoveryeducation.com>

Certificate maker: <http://www.certificate-maker.com>

*PDFforge* PDF maker: <http://www.pdf-magazine.com>

*PageBreeze* forms maker: <http://www.formbreeze.com>

#### Data collection and analysis tools

Listing of free statistical software: <http://www.freestatistics.info/en>

*Engrade*: <http://www.engage.com>

#### Graphics tools

*Inkscape*: <http://inkscape.org>

*Tux Paint* drawing software: <http://tuxpaint.org>

*Gimp* image editing software: <http://www.gimp.org>

Charting/graphing tools: <http://www.educational-freeware.com>

Free WAV sound files: [http://www.thefreesite.com/Free\\_Sounds/Free\\_WAVs/](http://www.thefreesite.com/Free_Sounds/Free_WAVs/)

*Sourceforge* font collections: <http://sourceforge.net/projects/worldfonts>

Open font library: <https://launchpad.net/openfontlibrary>

Free animations: <http://www.free-animations.co.uk>

*Continued*

**Planning and organizing tools**    *EnGrade* gradebook: <http://www.engage.com>  
*OpenSIS* student information system: <http://opensis.com>  
*SchoolForge* SIS: <http://www.schoolforge.net>  
 Parent-teacher conference scheduler: <http://www.ptcfast.com>

**Research and reference tools**    *StarDict*: <http://stardict.sourceforge.net/Dictionaries.php>  
 Wikipedia: <http://en.wikipedia.org>

**Content-area tools**    *Archimedes CAD* system: <http://archimedes.codeplex.com>  
*Audacity* sound editor software: <http://audacity.sourceforge.net>  
*Music Editor Free*: <http://www.music-editor.net>  
 Free online readability calculator: <http://www.online-utility.org>  
 Online graphing calculator: <http://www.coolmath.com/graphit>  
 GPS education resources: <http://www.gpseducationresource.com>  
 U.S. Census Bureau *TIGERLine* GIS files: <http://www.census.gov/geo/www/tiger/>  
 Language translators: <http://babelfish.yahoo.com> or <http://translate.google.com>

allowing teachers and students to design elaborate printed products, however, desktop publishing tools give them the important advantage of complete control over a potentially powerful form of communication. This control over the form and appearance of the printed page is the defining quality of **desktop publishing**, a term coined in 1984 by Paul Brainerd, founder of the Aldus Corporation, to mean using a combination of software, microcomputers, and printers to allow individuals to be their own publishers.

**Desktop publishing versus word processing software.** Though desktop publishing software and word processing software are different tools, it is possible to do some kinds of desktop publishing with word processing software. Just as with desktop publishing software, word processing programs allow users to mix text and graphics on each page. The primary difference between word processing software and desktop publishing software is that the latter is designed to create documents as separate pages that are then linked together; the user clicks on an icon representing each page, and only one page or facing pages display. On the other hand, word processing “flows” pages in a continuous stream through a document; the user scrolls down to view pages in the document. Because desktop publishing software allows

pages to be viewed as separate units, it provides more flexibility with the placement and formats of both text and graphics on individual pages.

You can use any available word processing software package to create most of the desktop publishing products you want to produce in a school environment (e.g., classroom brochures and newsletters). The more advanced layout features offered by desktop publishing software (e.g., elaborate layering of text and graphics elements) are needed only if you are teaching students how to design and lay out large, complex documents such as newspapers and books.

**Example classroom applications.** Desktop publishing software can be used for many of the same classroom activities and products as word processing software. Desktop publishing is the strategy of choice, however, to produce elaborate, graphic-oriented documents (e.g., flyers and posters, brochures, newsletters and magazines, and books and booklets), and teachers can structure some highly motivating classroom projects around these products. Instructional benefits for desktop publishing include increases in children’s self-esteem when they publish their own work, heightened interest in writing and motivation to write for audiences outside the classroom, and

**TABLE 2** Overview of Materials Generator Software Tools

Tool Category	Example Software Tools	Purposes and Benefits
Desktop publishing software	<ul style="list-style-type: none"> <li>• Microsoft <i>Publisher</i> <a href="http://office.microsoft.com">http://office.microsoft.com</a></li> <li>• Adobe <i>InDesign</i> and <i>Pagemaker</i> <a href="http://adobe.com">http://adobe.com</a></li> <li>• <i>Quark Express</i>: <a href="http://www.quark.com">http://www.quark.com</a></li> </ul>	Students create their own letterhead, brochures, flyers/posters, newsletters, newspapers, and books
Web page design software	<ul style="list-style-type: none"> <li>• Adobe <i>Dreamweaver</i> <a href="http://adobe.com">http://adobe.com</a></li> <li>• Microsoft <i>WebMatrix</i> <a href="http://www.microsoft.com">http://www.microsoft.com</a></li> </ul>	Teachers design web pages or websites to give information or house often-used links or lessons such as webquests; students design web pages to learn the skill or to display results of project work or research
Whiteboard activity software	<ul style="list-style-type: none"> <li>• <i>Notebook</i> (for use with Smart Boards) <a href="http://smarttech.com">http://smarttech.com</a></li> <li>• <i>ActivStudio</i> or <i>ActivInspire</i> (for use with Prometheus Boards) <a href="http://www.prometheanworld.com">http://www.prometheanworld.com</a></li> </ul>	Teachers create lessons for use with interactive whiteboards
Test and rubric generators	<ul style="list-style-type: none"> <li>• <i>Exam View Learning Series</i> <a href="http://www.einstruction.com">http://www.einstruction.com</a></li> <li>• <i>Test Creator</i> <a href="http://www.centronsoftware.com">http://www.centronsoftware.com</a></li> <li>• <i>Wondershare QuizCreator</i> <a href="http://www.sameshow.com">http://www.sameshow.com</a></li> <li>• <i>EasyTestMaker</i> <a href="http://www.easytestmaker.com">http://www.easytestmaker.com</a></li> <li>• <i>RubiStar</i> (use program or pre-made rubrics) <a href="http://rubistar.4teachers.org">http://rubistar.4teachers.org</a></li> </ul>	Teachers create tests and test item banks, administer tests online; teachers create or adopt rubrics for grading complex products or performances
Test and rubric generators (continued)	<ul style="list-style-type: none"> <li>• <i>Rubric Builder</i> <a href="http://www.rubricbuilder.on.ca">http://www.rubricbuilder.on.ca</a></li> <li>• <i>Rubric Maker</i> <a href="http://recipes.tech4learning.com">http://recipes.tech4learning.com</a></li> </ul>	
Worksheet and puzzle generators	<ul style="list-style-type: none"> <li>• <i>Crossword Puzzle Maker</i> <a href="http://www.armoredpenguin.com">http://www.armoredpenguin.com</a></li> <li>• <i>Worksheet Works</i> <a href="http://www.worksheetworks.com">http://www.worksheetworks.com</a></li> <li>• <i>Quia Web</i> <a href="http://www.quia.com">http://www.quia.com</a></li> </ul>	Teachers create puzzles and worksheets to allow skill practice
IEP Generators	<ul style="list-style-type: none"> <li>• <i>IEP Online</i> and <i>EasyIEP</i> <a href="http://www.publicconsultinggroup.com">http://www.publicconsultinggroup.com</a></li> <li>• <i>IEP Planet</i> <a href="http://www.visionplanet.com">http://www.visionplanet.com</a></li> <li>• <i>IEP4U</i> <a href="http://www.iep4u.com">http://www.iep4u.com</a></li> </ul>	
Graphic document makers	<ul style="list-style-type: none"> <li>• <i>Print Shop Deluxe</i> <a href="http://www.broderbund.com">http://www.broderbund.com</a></li> <li>• <i>Smart Draw</i> <a href="http://www.smartdraw.com">http://www.smartdraw.com</a></li> </ul>	Teachers and students create awards, recognitions, flyers, cards, and other decorated documents
PDF and forms makers	<ul style="list-style-type: none"> <li>• Adobe <i>Acrobat Pro</i> <a href="http://adobe.com">http://adobe.com</a></li> <li>• <i>PDF Maker Pilot</i> <a href="http://www.colorpilot.com">http://www.colorpilot.com</a></li> <li>• <i>Cute PDF</i> <a href="http://www.cutepdf.com">http://www.cutepdf.com</a></li> <li>• <i>FormArtist Professional</i> <a href="http://www.quask.com">http://www.quask.com</a></li> </ul>	Teachers and students create documents in Portable Document Format (PDF) and create forms that can be completed online



improved learning through small group collaboration. Here is a list of common classroom applications and ideas for implementing them:

- » **Practice in grammar, spelling, and communication**—The activity of creating a flyer or brochure can become an opportunity to learn about designing attractive and interesting communications and to apply language usage skills.
- » **Methods of reporting research findings**—Popular examples of using desktop publishing projects to report on students' research include creating travel brochures that report on student exploration during field trips, descriptions of the local region, and creative descriptions of organizations or activities. Sometimes this type of activity represents the culmination of a large project, such as a series of science experiments or a social studies research unit; sometimes it simply is a way for every student to contribute writing for a class project. All of these projects are highly motivational to students, and they attract “good press” for the teacher and the school.
- » **Opportunities for creative works**—Even very young students are thrilled to produce and display their own personal books, which sometimes represent work produced over the course of a school year. Sometimes the books show creative works resulting from a competition; frequently, examples of students' best work are collected for a particular topic or time period. Students can sell their publications as a fund-raising activity, but this kind of project also reaps other benefits for students of all abilities. Teachers report that getting published increases students' pride in their work and makes them want to spend more time on it.

**Criteria for effective desktop publishing.** Desktop-published products have greater impact and communicate the author's intent more clearly if they reflect some fairly simple design criteria. These include:

- » **Use a limited number of typefaces (fonts)**—Unusual typefaces or **fonts** can help direct the eye toward text, but too many different fonts on a page can be distracting, and some fancy fonts are difficult to read.
- » **Use different fonts for title and text**—To aid the reader, use a **serif typeface** (a font with small curves or “hands and feet” that extend from the ends of the letters) for text in the main body of the document. Use a **sans serif typeface**, a font without extensions, for titles and headlines.
- » **Use appropriate sizes for type**—Make the type large enough to assist the reader (e.g., younger readers usually need large point sizes), but not too large to dominate the page.

- » **Avoid overuse of type styles**—Breaking up text with too many style changes interferes with reading. Avoid excessive underlining, boldfacing, and italics.
- » **Match text and background colors**—Use white or yellow type on a black block to add drama. Avoid color combinations that can be difficult to read (e.g., orange on green or red on blue).
- » **Use visual cues**—Attract reader attention to important information on the page by using frames or boxes around text; bullets or arrows to designate important points; shading of the part of the page behind the important text; different text styles (e.g., boldface or italic type); and captions for pictures and diagrams.
- » **Use white space well**—There is a saying in advertising that “white space sells.” Don't be afraid to leave areas in a document with nothing in them at all to help focus attention on areas that do contain information.
- » **Create and use graphics carefully**—Use pictures and designs to focus attention and convey information, but remember that too many elaborate pictures or graphic designs can be distracting.
- » **Avoid common text format errors**—Common desktop design pitfalls include using irregularly shaped text blocks and angled type, both of which are difficult to read.
- » **Avoid common text break errors**—Use desktop publishing software features to control for widows and orphans (leftover single words and phrases at the tops or bottoms of pages) and excessive hyphenation.

## Web Design Software

Although educators and others can create web pages and websites using a high-level programming language called **HTML** (which stands for hypertext markup language), it is easier and faster to use a tool called **web design software**. Also known as **web page editors**, these tools are authoring programs that allow people to create web pages in the same way they would use word processing to create documents. They insert text, graphics, and hypermedia links to create the pages, and the editor software automatically creates the HTML that allows the pages to be linked together and placed on the Internet.

Teachers and students can use web design software to create web pages for both instructional and productivity applications. Some common uses include:

- » **Classroom news, activities, and resources**—Many teachers use HTML editors to create their own classroom websites. These are multi-purpose sites with items ranging from announcements and information about

current curriculum to locations from which students and/or parents may download handouts or homework. They can also have links to Internet sites that teachers know they will be using often to support instruction. For example, if they use certain puzzles and games to provide student practice, they can have part of the site that has links to these activities.

- » **Web-based lessons**—Teachers can use HTML editors to create their own instructional activities students can do on the web. For example, a popular type of web-based lesson is the **webquest**. According to the Webquest.org website, a webquest is “an inquiry-oriented lesson format in which most or all the information that learners work with comes from the web. The model was developed by Bernie Dodge at San Diego State University in February, 1995.” An example webquest is shown in Technology Integration Example 1.
- » **Student-produced work**—Teachers may choose to have students create web pages instead of documents to show off their creative work or research results. Students find it very motivating when they realize that their work will be “on the web” and can be seen by anyone who is on the Internet.

## TECHNOLOGY INTEGRATION EXAMPLE 1

### SAMPLE HTML EDITOR APPLICATION

**TITLE:** Webquest—Introducing the English Language!

**CONTENT AREA/TOPIC:** English as a Second Language

**GRADE LEVELS:** 9–10

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: English; Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information

**DESCRIPTION:** ESL students use webquest directions and links to build a factbook on an English-speaking country of their choice. Doing the activities in small groups, they build their collaborative skills, knowledge of the history of the English language, and their English listening, reading, vocabulary, and writing skills.

**Source:** Based on a concept from “A Guide to the World of the English Language” in the webquest collection at <http://questgarden.com> (also see <http://questgarden.com/112/97/8/101117112129>)

## Interactive Whiteboard Activity Software

An **interactive whiteboard** is the electronic version of a regular whiteboard, a white, glossy surface that uses erasable markers and can play the same role as a chalkboard. Interactive whiteboards are screens that are connected to a computer and digital projector and allow information projected on the screen to be manipulated with special pens or one’s hands. Some systems also allow drawings or notes from a given session to be saved and brought back later. The most popular interactive whiteboards are Prometheus’ Promethean ActivBoard® and SMART Technology’s SMART Board®. A related device also developed by Prometheus is the **SMART Table Interactive Learning Center**®, which is an electronic table with a touch-screen surface that several students can give input to at the same time. Each brand of interactive whiteboards comes with its own programs, called **interactive whiteboard activity software**, that allows teachers to author and display lessons for use with the systems. For example, the interactive whiteboard activity software used with a SMART Board® is called *Notebook* (see Figure 1), and the programs used with the Promethean ActivBoard® interactive whiteboard are called *ActivStudio* and *ActivInspire*. The programs come with a resource bank of images, graphics tools, and text tools that teachers can use to author programs in much the same way as they would use *PowerPoint*’s program and resources to create slides. Whiteboard activity software is required to give whiteboard lessons their interactive qualities. For example, teachers may use it to develop a lesson that allows students to move objects around on the whiteboard or touch the screen to select or enter an answer to a mathematics problem.

Companies that market interactive whiteboards provide the software as a free download to those who purchase their whiteboards. Whiteboards have become very popular in



Teachers may use interactive whiteboard activity software to develop lessons in which students move objects around on the whiteboard or touch the screen to select or enter answers.

Photo by W. Wiencke.

**FIGURE 1** Sample Screen from SmartBoard Notebook Software



Source: <http://smarttech.com>. Copyright SMART Technologies. All rights reserved.

schools, so this chapter includes a list of top ten ways teachers can use them (see the Top Ten feature), as well as a Hot Topic for Debate that focuses on their use. For a sample lesson designed with this kind of software tool, see Technology Integration Example 2.

## Test Generators and Rubric Generators

Software tools are available to help teachers with what many consider to be one of their most onerous and time-consuming instructional tasks: producing tests and other kinds of assessments. Test generators and rubric generators are shown in Table 2, which also lists where to locate several of these tools.

**Test generators.** Teachers use **test generators** to create and enter questions, and then they have the program prepare the test. The teacher may print the required number of copies on the printer or print only one copy and make the required number of copies on a copy machine. The features of test generators vary, but the following capabilities are common and offer several advantages, even over word processing programs:

- » **Test creation and revision procedures**—The software produces tests in a standard layout; the teacher need not worry about arranging the spacing and format of the page. The software prompts teachers to create tests item by item in formats such as multiple choice, fill in

## TECHNOLOGY INTEGRATION EXAMPLE 2

### SAMPLE WHITEBOARD APPLICATION

**TITLE:** The Road to Revolution

**CONTENT AREA/TOPIC:** Social studies, history

**GRADE LEVELS:** 9–12

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Social studies; Communication and Collaboration: Communicate clearly; Information, Media, and Technology Skills: Access and evaluate information; Media literacy: Create media products

**DESCRIPTION:** Students listen to scenarios of events leading up to the Revolutionary War as the teacher displays information about the events on the whiteboard. As a whole group, students choose what they would do in response to each event. Each choice leads them to the next event where they see results of their choices. In the end, they reach the point where Britain closes Boston Harbor, and students must decide whether they identified most with Loyalists, Patriots, or Neutralists.

**Source:** Based on a concept from the Smart Exchange lesson “The Road to Revolution” at <http://exchange.smarttech.com>

the blank, true/false, matching, and—less often—short answer and essay. Changes, deletions, and updates to questions are also easy to accomplish, again without concern for page format.

- » **Random generation of questions**—Test items are selected randomly from an item pool to create different versions of a test. This is especially helpful when a teacher wants to prevent “wandering eye syndrome” as students take a test.
- » **Selection of questions based on criteria**—Programs usually allow teachers to specify criteria for generating a test. For example, items can be requested in a specific content area, matched to certain objectives, or set up in a certain format, such as short-answer items only.
- » **Answer keys**—Most programs automatically provide an answer key at the time the test is generated. This is helpful with grading, especially if different versions of the test are used.



# TOP TEN

## Integration Strategies for Interactive Whiteboards

The best kinds and uses of software tools such as whiteboard software depend on the content area and skills teachers need to address. The ten uses given here reflect some of the most popular strategies described in the literature.

SOURCE	TRACK	SELECTION
Teacher-led classroom presentations and demos	<b>1</b>	Teachers lecture, illustrate concepts, and/or give examples by using the whiteboard to project <i>PowerPoint</i> presentations, Internet sites (e.g., for virtual field trips), videos (e.g., to show visual examples), and/or software screens (e.g., to demonstrate how to use the software). They may also make notes on the whiteboard during the presentation and save them to bring up later, if desired.
Student classroom demos	<b>2</b>	After teachers illustrate concepts by moving text or objects around and/or making notes on the board in front of the room, a few of the students further illustrate concepts by doing sample activities.
Teacher-led whole-class activities	<b>3</b>	Teachers engage a whole class in an activity by using the whiteboard to project Internet sites or software screens (e.g., for story-starters or creating products as a whole group). Students come up to the board to give their input.
Teacher lab demos	<b>4</b>	Teachers illustrate concepts in front of the room while students watch and work on lab computers.
Students' classroom practice	<b>5</b>	All kids in the class practice skills they have learned by taking turns moving text or objects around on the board in front of the room using game or drill formats.
Clicker-based interactions: Formative assessment	<b>6</b>	The teacher checks understanding periodically by projecting items one at a time, and all students give responses.
Clicker-based interactions: Regular assessment	<b>7</b>	The teacher grades students by projecting items to which all students respond.
Clicker-based interactions: Polling	<b>8</b>	Students give responses to get class opinions and/or chart group results to give feedback.
Small group-based: Practice on a SMART table	<b>9</b>	Students work in small groups to practice problems together.
Small group-based: Product creation on a SMART table	<b>10</b>	Students work in groups to create a product such as a design.



## DO CLASSROOMS NEED INTERACTIVE WHITEBOARDS?

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 her February 2011 (vol. 8, no. 2) article in the *Teacher.Net Gazette*, "Top 10 Ways to Use Interactive White Boards in

Elementary Classrooms," Yenner says that interactive whiteboards are a breakthrough technology, making possible a variety of new ways to engage students and make teachers' work more efficient. However, other authors are more critical. One post in the *Innovative Educator* blog gave "10 Reasons to Ditch the Board," saying whiteboards have few additional capabilities to make them worth the money. Do interactive whiteboards have unique and powerful characteristics that energize teaching and learning, or are they being oversold? What evidence can you cite that they have (or have the potential to have) substantial impact on teacher practice and student outcomes?

» **Test item banks**—Many test generators allow use of existing question pools, or **test item banks**, and some offer these banks for purchase in various content areas. Some programs also import question banks prepared on word processors.

Most test generators offer only on-paper versions of tests, but some allow students to take tests on-screen after they are prepared. The latter type is discussed later in this chapter under Data Collection and Analysis Tools, since on-screen testing systems also collect and summarize data as they grade tests.

**Online rubric generators.** The popularity of rubrics has grown to such an extent that several Internet sites offer free rubric generators. The teacher follows a set of prompts, and the system creates a rubric that can be printed out or referred to online. See a list of rubric generation sites in Table 2 and in the Open-Source Options feature.

### Worksheet and Puzzle Generators

Teachers also use software to produce worksheets, in much the same way as they do to generate tests. **Worksheet generators** help teachers produce exercises for practice rather than test items. Like test generator software, worksheet

generator software prompts the teacher to enter questions of various kinds, but it usually offers no options for completing exercises on-screen or for grading them. In many cases, test generator software and worksheet generator software are similar enough to be used interchangeably, and some packages are intended for both purposes. **Puzzle generators** automatically format and create crosswords, word search puzzles, and similar game-like activities. The teacher enters the content, and the software formats the puzzle. Refer to Table 2 for popular worksheet and puzzle generation sites. Common uses of worksheet and puzzle generators include:

- » Practice for lower level skills, such as math facts
- » **Cloze exercises** (comprehension exercises with certain words removed and students fill in the blanks)
- » Exercises to review words and definitions

### Individualized Education Program (IEP) Generators

The increased emphasis on school and teacher accountability means more paperwork on student progress, and teachers of students with special needs seem to have the most paperwork requirements of all. Federal legislation, such as the Individuals with Disabilities Education Act (IDEA) and the Americans with Disabilities Act (ADA), requires that



## ADAPTING FOR SPECIAL NEEDS

### Software Tools

As students enter middle school, the demands of changing classrooms and teachers each hour challenge the organizational abilities of even the best students. Suddenly, they have to do assignments in many different subjects and must have books and folders to keep track of each subject. Fortunately, most middle schools have a school-wide system (e.g., assignment notebooks, folders, homework-help web pages) to help students get organized and keep track of all that they are supposed to know and do. However, by October each year some students are “organizationally failing,” which makes it difficult for them to do well in their classes.

While staying organized and keeping track of important details is a life-long challenge for everyone, difficulties with memory storage and retrieval is a fundamental characteristic of many individuals with learning disabilities. As a result, it is important to help these students find an information management system that is highly effective for them. Many of the following organizational tools have features that offer benefits to these students. (Note that each of these would probably require that someone help the student set it up to use it profitably):

- » *Evernote* (<http://www.evernote.com>)—Encourages users to make artifacts (a note, image, or URL) of things they have to do, which are then indexed and made searchable.
- » *PocketMod* (<http://www.pocketmod.com>)—Provides a way of creating a pocket guide of things to do and remember.
- » *Remember the Milk* (<http://www.rememberthemilk.com>)—Helps users create a system of reminders of tasks to do.
- » *Ta-da List* (<http://tadalist.com>)—An online to-do list maker.
- » *Things* (<http://culturedcode.com/things>)—Lets users create an agenda and daily/weekly/monthly to-do lists.
- » *Toodledo* (<http://www.toodledo.com>)—Helps users organize tasks they have to do into folders and subtasks.
- » *Todoist* (<http://todoist.com>)—An online task manager to help users keep organized.
- » *Vitalist* (<http://www.vitalist.com>)—A personal organization and productivity system.
- » *Voo2Do* (<http://voo2do.com>)—An online system that helps users track priority, due dates, and time estimates for a number of different tasks.

Contributed by Dave Edyburn

schools prepare an **individualized educational program**, or IEP, for each special needs student. These IEPs serve as blueprints for each special student’s instructional activities, and teachers must provide documentation that such a plan is on file and that it governs classroom activities. **IEP generator** software assists teachers in preparing IEPs (Wilson, Michaels, & Margolis, 2005). Like test and worksheet generators, IEP generators provide on-screen prompts that remind users of the required components in the plan. When a teacher finishes entering all the necessary information, the program prints out the IEP in a standard format. Some IEP generation programs also accept data updates on each student’s progress. See also the Adapting for Special Needs feature.

### Graphic Document Makers

**Graphic document makers** are software tools that simplify the activity of making highly graphic materials, such as awards certificates and greeting cards. They offer sets of clip art and predesigned templates to which teachers and students can add their own content. For example, teachers

have found certificates to be a useful kind of recognition. Certificates congratulate students for accomplishments, and the students can take them home and share them with parents and friends. Most certificate makers include numerous templates for various kinds of achievements, a feature that makes teachers prefer them over word processing software for these kinds of tasks. You can select the template that is appropriate for the kind of recognition intended (e.g., completing an activity, being a first-place winner) and enter the personal information for each recipient. Also, students frequently find it motivating to use these packages to design their own certificates, cards, and flyers. The most popular of these document makers is *Printshop* (Broderbund). This and similar software tools are listed in Table 2.

### PDF and Forms Makers

**Portable Document Format (PDF)** file software, created by Adobe, permits the viewing and sending of documents as images. Since they are viewed as images, the PDF document displays all of the formatting and design elements (e.g., margins, graphics) of the original document without requiring

access to the software used to create it. Adobe *Acrobat Pro* or a similar program is used to create these files, but Adobe also provides free software to read documents saved in PDF format (Adobe *Reader*). PDF software is often used in conjunction with **forms makers** such as *PDF Maker Pilot*, a software tool that creates documents and web pages with forms that can be filled in on-screen. Teachers find forms makers useful because they make it easier to create forms to collect information from students, parents, or faculty or to implement surveys as part of research projects. Formatting even the simplest form can be time consuming on a word processor. These software tools structure the process and make the design simple to accomplish. As teachers create these forms, they can store them as templates for later use, perhaps with revisions.

## USING DATA COLLECTION AND ANALYSIS TOOLS

Data collection and analysis tools include database software, electronic gradebooks, statistical packages, online survey sites, student information systems, online and computer-based testing systems, and student response systems, or clickers. A summary of these tools, with sample products and classroom uses, is shown in Table 3.

### Database Software

**Databases** are computer programs that allow users to store, organize, and manipulate information, including both text and numerical data. Database software can perform some calculations, but its real power lies in allowing people to locate information through keyword searches. A database program is most often compared to a file cabinet or a Rolodex card file. Like these pre-computer devices, the purpose of a database is to store important information in a way that makes it easy to locate later. This capability has become increasingly important as society's store of essential information grows in volume and complexity.

People often use the term *database* to refer both to the computer program and to the product it creates; however, database products are also called files. Whereas a spreadsheet stores an item of data in a cell, a database stores one item of data in a location usually called a **field**. Although each field represents one item of information in a database, perhaps the more important unit of information is a **record**, which stores all items of information related to a particular database entry.

For example, in a database of student records, each record corresponds to a student, and a record consists of several fields of information about the student, such as name,

address, age, and parents' names. In a database of information about a school's inventory of instructional resources, each record represents one resource and consists of several fields describing aspects such as title, publisher, date published, and location.

**A shift in database uses and instruction.** After microcomputers became popular in the 1980s, database programs became nearly as widely used as word processing and spreadsheet programs. Teachers used them for recordkeeping tasks and taught students how to build and use database files. Educational technology literature reflected numerous K–12 lessons around building and using database files, both to teach the use of databases in an Information Society and to teach inquiry skills in science and social studies. Teachers were encouraged to teach database concepts to students as early as second grade.

But nowadays, most teachers don't create their own management systems to keep inventories of classroom materials or records on student performance; they rely instead on systems in the main office for such vital information. Teachers use prepared databases much more widely than ever before, but they do not usually create them. Instructional uses, too, have become more focused on using existing databases, rather than building them. Though database construction is still taught in some classrooms (e.g., business and technology classes), more often database use focuses on using already-built database files in science or social studies. For example, Southworth, Mokros, Dorsey, and Smith (2010) report using a program called GENIQUEST, a database of fictional information about dragons that helps teach genetic concepts in biology. Southworth et al. stressed the importance of such tools in helping students become “computational thinkers” in a modern world that is “increasingly defined by data” (p. 29). Wilson, Trautmann, MaKinster, and Barker (2010) describe using Science Pipes, a product designed by the Cornell Lab of Ornithology, to help students “conduct guided inquiries or hypothesis-driven research to investigate patterns and trends—such as the distribution of plant and animal species across biomes or the migration routes of various bird species” (p. 35).

**Current database integration strategies.** Though most database instruction is in science and social studies, integration strategies have been designed for a variety of topics across the curriculum. These strategies include the following.

- » **Teaching research and study skills**—Skills in locating and organizing information to answer questions and learn new concepts have always been as fundamental as reading and writing skills. Much of the world's

**TABLE 3 Overview of Data Collection and Analysis Tools**

Tool Category	Example Software Tools	Purposes and Benefits
Database software	<ul style="list-style-type: none"> <li>• <i>FileMaker</i> <a href="http://www.filemaker.com">http://www.filemaker.com</a></li> <li>• <i>Quickbase</i> <a href="http://quickbase.intuit.com">http://quickbase.intuit.com</a></li> <li>• <i>Microsoft Access</i> <a href="http://office.microsoft.com/en-us/access">http://office.microsoft.com/en-us/access</a></li> </ul>	Teachers teach how to build and use database software in business and technology classes
Electronic gradebooks	<ul style="list-style-type: none"> <li>• <i>PinnacleGrade Gradebook</i> <a href="http://www.globalscholar.com">http://www.globalscholar.com</a></li> <li>• Teacher Planet listing of many gradebook packages <a href="http://www.gradebooks4teachers.com">http://www.gradebooks4teachers.com</a></li> </ul>	Teachers keep track of and calculate student grades
Statistical packages	<ul style="list-style-type: none"> <li>• <i>SPSS</i> <a href="http://www.spss.com">http://www.spss.com</a></li> <li>• <i>SAS</i> <a href="http://www.sas.com">http://www.sas.com</a></li> <li>• <i>Analyse-it</i> <a href="http://www.analyse-it.com">http://www.analyse-it.com</a></li> <li>• <i>XLStat</i> <a href="http://www.xlstat.com">http://www.xlstat.com</a></li> <li>• <i>NCSS</i> <a href="http://www.ncss.com">http://www.ncss.com</a></li> <li>• <i>Stata</i> <a href="http://www.stata.com">http://www.stata.com</a></li> </ul>	Teachers use statistical procedures to analyze data from experiments and action research studies
Online survey tools	<ul style="list-style-type: none"> <li>• <i>SurveyMonkey</i> <a href="http://www.surveymonkey.com">http://www.surveymonkey.com</a></li> <li>• <i>Zoomerang</i> <a href="http://www.zoomerang.com">http://www.zoomerang.com</a></li> </ul>	Teachers design and implement online surveys to collect data for instructional purposes
Student information systems	<ul style="list-style-type: none"> <li>• <i>PowerSchool</i> <a href="http://www.pearsonschools.com">http://www.pearsonschools.com</a></li> <li>• <i>Pinnacle SIS</i> <a href="http://www.globalscholar.com">http://www.globalscholar.com</a></li> <li>• <i>Tyler SIS</i> <a href="http://www.tylertech.com/solutions-products/school-solutions">http://www.tylertech.com/solutions-products/school-solutions</a></li> <li>• <i>QuickSchools</i> <a href="http://www.quickschools.com">http://www.quickschools.com</a></li> </ul>	Teachers, administrators, and parents keep track of student and class progress on required curriculum objectives
Computer-based testing systems	<ul style="list-style-type: none"> <li>• <i>ExamBuilder</i> <a href="http://www.exambuilder.com">http://www.exambuilder.com</a></li> <li>• <i>Easy Test</i> <a href="http://www.easyteach.com/easytest.html">http://www.easyteach.com/easytest.html</a></li> <li>• <i>ComputerTest 2.0</i> <a href="http://www.cubeapps.com">http://www.cubeapps.com</a></li> </ul>	Students take tests on the computer or online, and the software grades tests and compiles data for grading and decision making
Student response systems or clickers	<ul style="list-style-type: none"> <li>• <i>Student Response Solutions</i> <a href="http://www.turningtechnologies.com">http://www.turningtechnologies.com</a></li> <li>• <i>Smart Response</i> <a href="http://smarttech.com">http://smarttech.com</a></li> <li>• <i>ActiVote, ActivExpression, ActivEngage</i> <a href="http://www.prometheanworld.com">http://www.prometheanworld.com</a></li> <li>• <i>iRespond</i> <a href="http://www.irespond.com">http://www.irespond.com</a></li> </ul>	Teacher displays a question or problem (sometimes on interactive whiteboard), all students answer it at the same time, and the system summarizes and displays results immediately; teachers use the systems to engage students and check comprehension



information is stored in databases, and these “information banks” are becoming more available to students and other nontechnical people for everyday use. As the volume of information in our society increases, students’ need to learn how to locate important information quickly also grows. Before they owned computers, families bought reference tools, such as a good dictionary and a set of encyclopedias, so that children could do research for their school reports and other assignments. Today, these and other sources are stored on electronic media, and students need to know how to do computer searches of these references. Many database activities are designed to instruct students in these kinds of searches. Database exercises help students realize how many organizations store data and provide them with practice in looking for information in various sources.

- » **Understanding the power of information “pictures”**—Students need to be able to do their own **data mining**, or looking for hidden patterns in a group of data. To do that, they need to understand the persuasive power of information organized into databases. Sometimes a database can generate information “pictures” or relationships among bits of information that may not be visible in any other way. Although these pictures may or may not be completely accurate, many decisions in our society are based on them. For example, the U.S. government uses information databases on those who have been convicted of past income tax offenses to generate descriptive profiles of people who may be likely to try to defraud the government in the future. Students can learn to use database information to generate these types of pictures.
- » **Posing and testing hypotheses**—Many problem-solving activities involve asking questions and locating information to answer them. Using databases is an ideal way to teach and provide practice with this kind of problem solving. Students can either research prepared databases full of information related to a content area, or they can create their own databases, which is not as common. Either way, these activities encourage them to look for information that will support or refute a position.

## Electronic Gradebooks

Although some teachers prefer to keep their grades on flexible spreadsheet software, many prefer to use software designed exclusively for this purpose. An **electronic gradebook** (electronic grade-keeping) program allows a teacher to enter student names, test/assignment names, data from tests, and weighting information for specific test scores. The program then analyzes the data and prints reports based on

this information. Some gradebooks even offer limited-purpose word processing capabilities to enter notes about tests. The software automatically generates averages and weighted averages for each student and averages across all students on a given test. Gradebooks require less teacher setup time than spreadsheets do, but they also allow less flexibility on format options. Many schools today use district-wide gradebooks, often as part of student information systems (described later in this chapter), for uniformity across all grading programs. A sample gradebook screen is shown in Figure 2.

## Statistical Software Packages

As researcher and author L. R. Gay (1992) once joked, many teachers believe that the field of statistics should be renamed “sadistics.” Yet teachers may find several uses for statistical analyses. If they choose to do action research in their classrooms, teachers must collect and analyze data on student performance. Depending on the type of research, several typical analyses yield helpful information, including descriptive statistics (e.g., means and standard deviations) and inferential statistics (e.g., t-tests and analyses of variance). **Statistical software packages** allow users to enter data and perform calculations needed to accomplish descriptive and inferential analysis procedures. In addition to its use in analyzing data from research and testing, teachers may also find statistical software useful when they have to teach statistical procedures to their students in, for example, a business education course or an AP statistics course. Naturally, a teacher must have considerable knowledge of the proper applications of various statistical procedures; the software merely handles the arithmetic. But this alone can save considerable time. Popular statistical software tools are listed in Table 3.

**FIGURE 2** Sample Screen from the Track My Grades Gradebook Package

Test/Assignment	Score	Weight	Grade	Weighted Score	Average	Standard Deviation	Minimum	Maximum
1. Math	85	1	B	85	85	10	70	100
2. English	78	1	C	78	82	12	65	95
3. Science	92	1	A	92	88	8	75	100
4. Social Studies	88	1	B	88	85	15	70	100
5. Art	95	1	A	95	90	5	80	100
6. Music	80	1	C	80	85	10	70	100
7. Physical Education	90	1	B	90	88	12	75	100
8. Health	85	1	B	85	82	15	65	100
9. Career	75	1	C	75	80	10	60	100
10. Foreign Language	88	1	B	88	85	15	70	100
11. Computer	90	1	B	90	88	12	75	100
12. Driver's Ed	85	1	B	85	82	15	65	100
13. Safety	95	1	A	95	90	5	80	100
14. Civics	80	1	C	80	85	10	70	100
15. Business	88	1	B	88	85	15	70	100
16. State History	90	1	B	90	88	12	75	100
17. World History	85	1	B	85	82	15	65	100

Source: <http://www.trackmygrades.com>. Reprinted by permission.

## Online Survey Tools

A number of online sites, such as SurveyMonkey and Zoomerang, are available to allow teachers and students to design and implement their own surveys and questionnaires. This way of collecting data has become increasingly popular, since it eliminates the need for postal mailings or for respondents being in any particular location to complete a survey. An example of an online survey site is shown in Figure 3.

**Features of online survey tools.** Though online survey tools vary in format and capabilities, they have certain basic features in common. These include:

- » **Variety of item formats**—Items can be in formats that include multiple choice, true/false, short answer, essay, and Likert scale (e.g., strongly disagree to strongly agree). Various item formats can appear in the same survey.
- » **Instant tracking and visual summaries of results**—After the survey is implemented and people begin completing it, one can get immediate updates on how many people have participated and what the data look like in bar or graph form.
- » **Data downloads**—Systems also permit users to get a file of data resulting from surveys in spreadsheet-ready formats.

Most online survey tools have a free version with fewer capabilities than the fee-based version.

### FIGURE 3 Sample Screen from Survey Monkey site



Source: SurveyMonkey, <http://www.surveymonkey.com>. Reprinted by permission.

**Integration strategies for online survey tools.** Both productivity and instructional uses have been reported for online survey tools. For example, Looney (2008) says that online surveys are an ideal way to allow students to give their feedback on any given topic, such as how they liked a classroom activity or how they feel about candidates up for election. For a sample lesson designed with this kind of software tool, see Technology Integration Example 3. Instructional integration strategies for online surveys include the following:

- » **Student polling**—Either the teacher or students design items that poll students on their opinions. Then the teacher summarizes data produced by the poll to show students the class opinions on a given topic. The purpose for doing this activity can range from simply illustrating how a poll works to providing data that are meaningful to students in order to teach analysis skills.

## TECHNOLOGY INTEGRATION EXAMPLE 3

### ONLINE SURVEY TOOLS

**TITLE:** Polling the Class Prior to a Statewide Vote

**CONTENT AREA/TOPIC:** Civics, elections

**GRADE LEVELS:** 9–12

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject—Government & Civics; Critical Thinking and Problem Solving; Use systems thinking; Information, Media, and Technology Skills: Use and manage information; ICT: Apply technology effectively

**DESCRIPTION:** Prior to a statewide vote on proposed amendments to the statewide constitution, students create a class or school survey to poll students on how and why they think the state's citizens should vote. After the survey is implemented and data are available, they use data to make charts and graphs of results on each item. After the election, they analyze and discuss reasons for similarities and differences between a poll's results and those of the actual election.

**Source:** Based on a concept from the "Constitutional Amendments Survey" lesson plan submitted to the Technology website ([http://www.teach-nology.com/teachers/lesson\\_plans/history/voting](http://www.teach-nology.com/teachers/lesson_plans/history/voting)) by Christy Clanton, Bay District Schools

- » **Generating data for graphic illustrations**—Either the teacher or students design a survey and place it online for the purpose of gathering data to create a graphic such as a pie chart or bar graph. Students get practice in reading and interpreting the graphic displays.
- » **Teaching survey design**—Students create and implement online surveys in order to learn how to create well-designed items and develop a survey instrument that communicates well and obtains the desired data.
- » **Teaching data analysis**—Either the teacher or students design a survey to gather data for the purpose of illustrating and allowing practice in how to do analyses such as means (averages), medians, modes, and percentages.
- » **Teaching math concepts**—The teacher implements an online survey that will provide data to illustrate math concepts such as probability.

## Student Information Systems

**Student information systems (SISs)** are software tools that help educators keep track of student, class, and school data (e.g., attendance, test scores) to maintain records and support decision making. Schools purchase various operations they want the system to keep track of. Depending on what they choose, the system may do any or all of the following:

- » Track and report on attendance
- » Maintain records on student demographic data (e.g., birth date, address)
- » Develop class scheduling
- » Track and report on test scores and achievement by objective
- » Allow parents to have online access to student grades and attendance information
- » Notify parents about problems with grades or attendance

In the 1970s, these systems were known by the general term **computer-managed instruction (CMI) systems**. At that time, there was a burgeoning interest in mastery learning in which teachers specified a sequence of objectives for students to learn and prescribed instruction to help the students master each objective. The teacher had to keep track of each student's performance on each objective—a mammoth record-keeping task. CMI systems, such as the Teaching Information Processing System (TIPS) and the Program for Learning in Accordance with Needs (PLAN), ran on large, mainframe computers and were designed to support teachers in these efforts.

Today's educators must also be concerned about monitoring student progress, but the concern now is in complying with accountability requirements such as those specified

by the No Child Left Behind Act. Also, these systems can make it easier for teachers to keep parents notified about student progress. Systems such as Pearson's *PowerSchool* and GlobalScholar's *Pinnacle SIS* allow parents and educators online access to students' grade reports. See Figure 4 for an example screen from one such system.

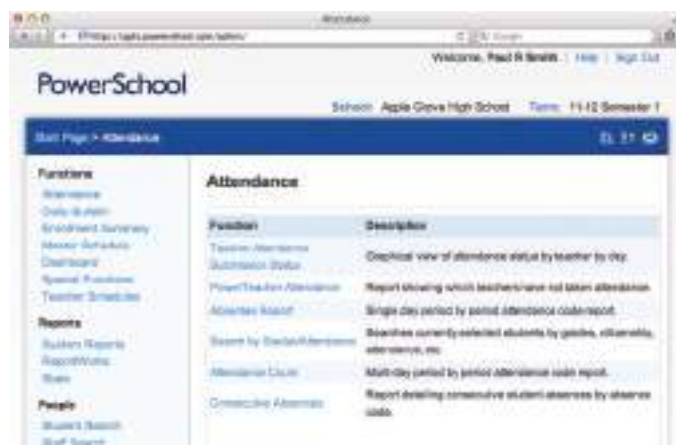
Some SISs are components of integrated learning systems (ILSs). Integration with ILSs allows instruction to be tailored to each student's needs and collects data as students go through the instruction. Reports show the teacher what students have accomplished and point out areas where they may still need assistance and off-computer work.

## Computer-Based Testing Systems

Also known as **computer-assisted testing**, computer-based testing systems allow students to take tests on-screen or to put test answers on optically scanned “bubble sheets,” and provide reports on performance data afterward. Some current testing systems overlap with the function of true test generators (see earlier description under Materials Generators), which are designed to produce tests from data banks. Some of the major standardized tests, such as the SAT and GRE, are now given on computerized testing systems, which offers benefits such as immediate knowledge of results. The capabilities of computerized testing systems let educators go beyond the limits of multiple-choice tests and make possible alternative assessments. These systems also simplify test scheduling, because everyone need not take tests at the same time.

With testing systems, tests can be shorter, since the software assesses each person's ability level with fewer questions. The software continuously analyzes performance and presents more or less difficult questions based on the student's performance, a capability known as **computer adaptive testing (CAT)** (Barla

**FIGURE 4** Sample Screen from PowerSchool



Source: Pearson PowerSchool. Reprinted by permission of Pearson Education.

et al., 2010). CAT is being used more and more frequently for testing in professional courses like those in nursing education. Computer-based testing of all kinds remains controversial, however. Some people feel that computer-based testing is not equivalent to other kinds of testing and may cause increased test anxiety in some students (Fritts & Marszalek, 2010).

## Student Response Systems (Clickers)

Unique among data collection resources, **student response systems** (also called personal response systems, **clickers**, or classroom response systems) are a combination of handheld hardware and software that permits each student in a classroom to answer a question simultaneously and permits the teacher to see and display a summary of results immediately. The software ranges from that sold with a textbook to new technologies where cellular phones can be used to respond to questions posed by the instructor. Johnson and McLeod (2004–2005) describe 11 such systems as well as a variety of instructional uses for them. Caldwell (2007) offers categories of activities teachers can do with these devices, as well as guidelines for writing good questions and a list of best-practice tips.

**Research on student response systems.** Though studies of these tools are usually in large-section courses in higher education, they usually report improved student engagement, more active learning, and greater achievement (Blood & Neel, 2008; Gauci, Dantas, Williams, & Kemm, 2009; Shaffer & Collura, 2009). Stowell, Oldham, and Bennett (2010) also found that students were less likely to conform to the group's opinion and felt more comfortable responding with this tool than raising their hands when questions being discussed were controversial.

**Integration strategies for student response systems.** Uses for this tool range from vocabulary games to comprehension

## TECHNOLOGY INTEGRATION EXAMPLE 4

### STUDENT RESPONSE SYSTEMS (CLICKERS)

**TITLE:** Fraction to Decimal Jeopardy

**CONTENT AREA/TOPIC:** Mathematics, fractions/decimals

**GRADE LEVEL:** 4

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subject: Science; Critical Thinking and Problem Solving: Reason effectively; Information Literacy: Use and manage information

**DESCRIPTION:** The teacher creates or downloads a Jeopardy game file to let students practice various skills in changing decimals to fractions, fractions to decimals, and expressing results in words. The class divides into two teams to play the game and divides up the response keys so that each team is using A–D or E–H keys to respond. For each question, the team with the highest percentage of correct responses earns the points and picks the next category and question to answer. The team with the most points at the end of the game wins.

**Source:** Based on a concept from the lesson plan "Fraction to Decimal Jeopardy" at the SMART Exchange website <http://exchange.smarttech.com>

checks during a classroom presentation and offer an easy way to engage all students at once. Successful uses have been reported in science (Moss & Crowley, 2011; Walgren, 2011), mathematics (Popelka, 2010), and English (Miller, 2009). For a sample lesson designed with this kind of software tool, see Technology Integration Example 4.

## USING GRAPHICS TOOLS

Graphics tools include draw/paint programs; image editing tools; charting/graphing tools; and clip art, photo, animation, sound, video, and font collections. A summary of these, with sample products and classroom uses, is shown in Table 4.

### Draw/Paint Programs

Drawing and painting software tools help teachers and students create their own graphics to insert into documents or web pages. In simpler draw/paint programs, such



Student Response Systems or "clickers" provide immediate feedback to support several kinds of whole-group teaching strategies.

Photo by W. Wiencke.

**TABLE 4 Overview of Graphics Tools**

Tool Category	Example Software Tools	Purposes and Benefits
Draw/paint programs	<ul style="list-style-type: none"> <li>• <i>Adobe Illustrator</i> <a href="http://www.adobe.com">http://www.adobe.com</a></li> <li>• <i>CorelDraw</i> <a href="http://www.corel.com">http://www.corel.com</a></li> <li>• <i>KidPix</i> <a href="http://www.broderbund.com">http://www.broderbund.com</a></li> </ul>	Teachers and students create their own drawings and illustrations to display on-screen or print
Image editing software	<ul style="list-style-type: none"> <li>• <i>Adobe Photoshop</i> <a href="http://www.adobe.com">http://www.adobe.com</a></li> <li>• <i>ACDSee Pro Photo Manager</i> <a href="http://www.directron.com">http://www.directron.com</a></li> </ul>	Teachers and students create, modify, and combine images (e.g., clip art, photos, drawings) to illustrate documents and web pages
Charting/graphing software	<ul style="list-style-type: none"> <li>• <i>SmartDraw</i> <a href="http://www.smartdraw.com">http://www.smartdraw.com</a> <a href="http://www.webopedia.com/">http://www.webopedia.com/</a></li> <li>• <i>The Graph Club 2.0</i> <a href="http://www.tomsnyder.com">http://www.tomsnyder.com</a></li> <li>• List of plotting/graphing software <a href="http://en.wikipedia.org/wiki/List_of_information_graphics_software">http://en.wikipedia.org/wiki/List_of_information_graphics_software</a></li> </ul>	Students create charts and graphs to illustrate and study data summaries
Media collections	<ul style="list-style-type: none"> <li>• Graphics for Teachers <a href="http://www.teachingheart.net">http://www.teachingheart.net</a></li> <li>• Microsoft Media Collections <a href="http://office.microsoft.com/en-us/images">http://office.microsoft.com/en-us/images</a></li> <li>• Istock Photos <a href="http://www.istockphoto.com">http://www.istockphoto.com</a></li> <li>• Digital Sound Factory (musical instruments) <a href="http://www.digitalsoundfactory.com">http://www.digitalsoundfactory.com</a></li> <li>• <i>Flaming Text</i> <a href="http://www.flamingtext.com">http://www.flamingtext.com</a></li> <li>• Adobe Fonts Collection <a href="http://www.adobe.com/type/collections.html">http://www.adobe.com/type/collections.html</a></li> <li>• Animation Factory <a href="http://www.animationfactory.com">http://www.animationfactory.com</a></li> </ul>	Teachers and students insert these media items into documents and media they create

as *Kid Pix*, users select graphics components (e.g., colors, shapes, lines) from menus and toolbars, making the programs so easy to use that anyone can sit down and create an image in a matter of minutes. Students may use these programs to illustrate their work or to help convey information in reports. Cause and Chen (2010) say that for young children, drawing is a representational form of communication that is a precursor to writing, and recommend drawing software on a tablet computer for its versatility. Walker-Dalhouse and Risko (2008) agree, finding that “children can use drawing software to illustrate text content and represent their interpretations of concepts learned” (p. 423). Lach, Little, and Nazzaro (2003) say the tools make possible a multiple-intelligences approach to science and art instruction, and Hakes and Eisenwine (2003) describe how to use these and other tools to enhance social studies instruction. Higher-end programs, such as *Adobe Illustrator*, make possible more complex drawings and require more

knowledge of art and graphic techniques. These are usually used in high school level communications and technology education courses.

## Image Editing Tools

To modify photographic images, **image editing programs** are the technology software tool of choice. These tools usually are used to enhance and format photos that are then imported into desktop publishing systems or web page products. Image editing programs are known for their sophistication and wide-ranging capabilities. Many of these packages, such as *Adobe Photoshop*, require considerable time to learn if one wants to become familiar with all facets of the technology, but the basic operations are still very powerful, easy to learn, and effective in the K–12 classroom. Technology Integration Example 5 shows how these programs could be used in a math/astronomy lesson.

## Charting/Graphing Tools

**Charting/graphing tools** automatically draw and print desired charts or graphs from data entered by users. The skills involved in reading, interpreting, and producing graphs and charts are useful both to students in school and adults in the workplace. However, people with limited artistic ability usually find it difficult to draw charts and graphics freehand. Fortunately, charting and graphing software takes the mechanical drudgery out of producing these useful “data pictures.” If students do not have to labor over rulers and pencils as they try to plot coordinates and set points, they can concentrate on the more important aspects of the graphics: the meaning of the data and what they represent. This kind of activity supports students in their

efforts at visualizing mathematical concepts and engaging in inquiry tasks.

Graphing activities in science, social studies, and geography also profit from applications of these kinds of software tools. Moersch (1995) lists and gives example instructional applications for nine kinds of software-produced graphs: bar, pie, stacked bar, X/Y, scatter, box, stem and leaf, best fit, and normal curve. Ruthven, Deane, and Hennessy (2009) view graphing as an essential tool to enhance algebra instruction. See Technology Integration Example 6 for an example lesson with graphing software.

## Clip Art, Photo, Animation, Sound, Video, and Font Collections

**Clip art** packages were originally collections of still pictures drawn by artists and graphics designers and placed in a book or on a disc for use by others. Nowadays, the idea of clip art has expanded to include drawings, cartoons, photos, and

### TECHNOLOGY INTEGRATION EXAMPLE 5

#### IMAGE EDITING SOFTWARE

**TITLE:** Bringing the Planets Closer to Home

**CONTENT AREA/TOPIC:** Mathematics (measurement), astronomy

**GRADE LEVEL:** 8–12

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Mathematics, Science; Critical Thinking and Problem Solving: Solve problems; ICT Literacy: Apply technology effectively

**DESCRIPTION:** Students begin by downloading NASA photos from the Internet (e.g., images of the solar system at <http://www.solarviews.com> or <http://solarsystem.nasa.gov>) and converting them to an uncompressed TIF format using an image editing program such as Adobe *Photoshop*. Their task is to learn how to measure the images. First, they use the software to calibrate the images (determine the scale) by comparing the size of each image to a known measurement, such as the diameter of Mars. Then they multiply the measured distance by the scale to determine the size of other features they have downloaded. In this way, the students can measure and compare features that change, such as the Martian and Earth polar ice caps. These measurements can be the basis of many projects to study space phenomena.

**Source:** Based on a concept from Slater, T., & Beaudrie, B. (2000). Far out measurements: Bringing the planets closer to home using image-processing techniques. *Learning and Leading with Technology*, 27(5), 36–41.

### TECHNOLOGY INTEGRATION EXAMPLE 6

#### CHARTING/GRAPHING SOFTWARE

**TITLE:** Engaging Special Education Student in Math Concepts

**CONTENT AREA/TOPIC:** Mathematics, special education

**GRADE LEVEL:** 2

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Mathematics; Critical Thinking and Problem Solving: Make judgments and decisions, solve problems; Information Literacy: Apply technology effectively

**DESCRIPTION:** In a two-week project that emphasizes authentic problem solving, students collect data about the success of their school’s food drive and use graphing software to graph the information. They enter data into a table, generate a bar graph, and hang the graph in the room as a focal point of discussion. The activity especially benefits students with challenges such as autism by preventing frustration with graphing tasks and keeping them focused on the concepts that data illustrate.

**Source:** Based on a concept from Ward, R. (2006). Engage students with graphing software. *Learning and Leading with Technology*, 34(1), 35.

animations—all of which are found easily on the Internet. For example, high-quality photos, illustrations, and videos can be found online at sites such as the ones shown in Table 4. When preparing presentations, you can use available art instead of drawing your own original images or taking your own photos. Most word processing, desktop publishing, image editing, and draw/paint programs can import these items from a disc or a website. Font collections are also available to expand the font options that come with a computer or software.

These collections offer valuable resources that help illustrate and decorate written products. Teachers find that such pictures help make flyers, books, and even letters and notices look more polished and professional. Some teachers feel that students are more motivated to write their own stories and reports when they can also illustrate them.

For teachers and students who want to develop their own websites or multimedia presentations, collections of sound effects and video clips (e.g., MPEG files) are also becoming common on the Internet, and many are free of charge. However, a system may need special software plug-ins, such as *Quicktime* or Adobe *Flash*, to incorporate these elements.

## USING PLANNING AND ORGANIZING TOOLS

Planning and organizing tools include outlining and concept mapping software, lesson planning software, and scheduling/time management tools. A summary of these, with sample products and classroom uses, is shown in Table 5.

## Outlining Tools and Concept Mapping Software

Several kinds of technology tools are available to help students learn writing skills or to assist accomplished writers in setting their thoughts in order prior to writing. **Outlining tools**, sometimes called electronic outliners, are programs designed to prompt writers as they develop outlines. For example, the software may automatically indent and/or supply the appropriate number or letter for each line in the outline. Outlining tools are offered either within word processing packages or as separate software packages for use before word processing.

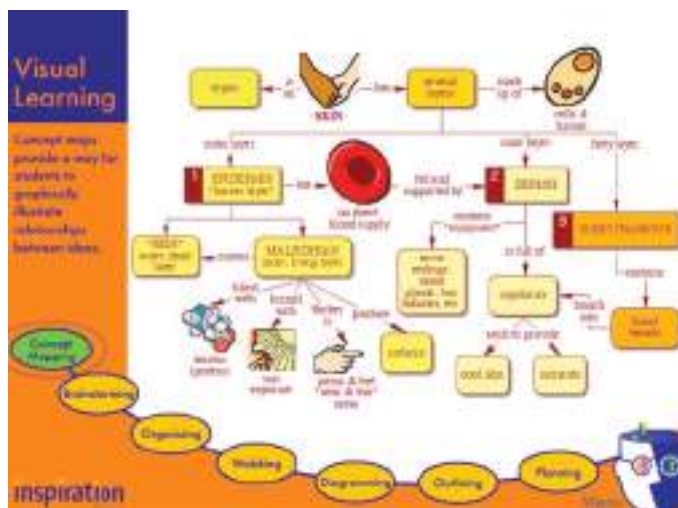
Other writing aids include software designed to get students started on writing reports or stories: a story starter. This kind of program provides a first line and invites students to supply subsequent lines. Other tools give students topic ideas and supply information about each topic that they can use in a writing assignment. Sometimes a software package combines outlining tools and other writing aids.

**Concept mapping software** tools are designed to help people think through and explore ideas or topics by developing concept maps. Concept maps are visual outlines of ideas that can offer useful alternatives to the strictly verbal representations provided by content outlines. The number of concept mapping software programs has grown over the past few years, with many of the programs being web-based or even free of charge. *Inspiration* is one of the most popular of these tools (see Figure 5, and *Kidspiration* is a version of this software designed for younger users). MacArthur (2009)

**TABLE 5** Overview of Planning and Organizing Tools

Tool Category	Example Software Tools	Purposes and Benefits
Outlining and concept mapping software	<ul style="list-style-type: none"> <li>• <i>Inspiration</i> <a href="http://www.inspiration.com">http://www.inspiration.com</a></li> <li>• <i>Kidspiration</i> <a href="http://www.inspiration.com/Kidspiration">http://www.inspiration.com/Kidspiration</a></li> <li>• <i>SmartDraw</i> <a href="http://www.smartdraw.com">http://www.smartdraw.com</a></li> </ul>	Help students organize their ideas in outline or concept map to prepare for writing or to examine story structures
Lesson planners	<ul style="list-style-type: none"> <li>• <i>PlanbookEdu</i> <a href="http://planbookedu.com">http://planbookedu.com</a></li> <li>• <i>ILessonPlan</i> <a href="http://www.ilessonplan.com">http://www.ilessonplan.com</a></li> <li>• <i>MyLessonPlanner</i> <a href="http://www.mylessonplanner.com">http://www.mylessonplanner.com</a></li> </ul>	Help teachers prepare and document lesson plans
Scheduling, calendar, and time management tools	<ul style="list-style-type: none"> <li>• FileBuzz Teacher Calendar Software <a href="http://www.filebuzz.com/Educational/1.html">http://www.filebuzz.com/Educational/1.html</a> <a href="http://www.webopedia.com">http://www.webopedia.com</a></li> <li>• Reel Logix Calendar Software <a href="http://www.thecalendarplanner.com">http://www.thecalendarplanner.com</a></li> <li>• <i>Easy Schedule Maker</i> <a href="http://www.patrena.com">http://www.patrena.com</a></li> </ul>	Help teachers organize their time and plan activities

**FIGURE 5** Sample Screen from *Inspiration*



Source: ©2011 Inspiration® Software, Inc. Used with permission.

discusses the research conducted on these powerful instructional tools and gives good examples of how they may be used to help struggling writers. (See Technology Integration Example 7.)

## Lesson Planning Software

Not all teachers rely heavily on written lesson plans to guide their teaching activities. However, many occasions demand some form of documentation to show what teachers are teaching and how they are teaching it. Tools that help teachers develop and document their descriptions of lessons are sometimes called lesson makers or lesson planners. Most of these programs simply provide on-screen prompts for specific lesson components, such as objectives, materials, and activity descriptions. They also print out lessons in standard formats, similar to the way test generators format printouts of tests.

## Scheduling, Calendar, and Time Management Tools

Several kinds of tools have been designed to help teachers organize their time and plan their activities. Schedule makers help formulate plans for daily, weekly, or monthly sequences of appointments and events. Calendar makers are similar planning tools that actually print graphic calendars of chosen months or years with the planned events printed under each day. Other time management tools are available to help remind users of events and responsibilities. The teacher enters activities and the dates on which they are to occur. Then, when he or she turns on the computer each

## TECHNOLOGY INTEGRATION EXAMPLE 7

### CONCEPT MAPPING SOFTWARE

**TITLE:** Authors in Residence and Online Mentors

**CONTENT AREA/TOPIC:** Language arts, writing

**GRADE LEVELS:** Elementary

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Mathematics; Critical thinking and problem solving—Make judgments and decisions, solve problems; Information Literacy—Apply technology effectively

**DESCRIPTION:** Students first use *Kidspiration* or *Inspiration* software to create a concept map for their written work. After they complete a word-processed first draft, they email the files to their mentors and receive comments, suggestions for improvements, and encouragement. For example, one mentor suggested that a young writer expand her story by playing a “what if” game. She asked what the characters in the story might do in response to the events she had already written. Then she could describe these responses in order to embellish her story. Students and mentors bond through this process, and students are more motivated to revise their writing.

**Source:** Based on a concept from Hagins, C., Auston, J., Timmons, T., & Weeg, P. (2004). Authors “in residence” make writing fun: Online mentors help fourth graders compose original stories. *Learning and Leading with Technology*, 31(6), 36–39.

day, the software displays on the screen a list of things to do. Some integrated packages combine all of these tools. Time management tools are especially popular applications on handheld computers, as the user can update the calendar at any time and place.

## USING RESEARCH AND REFERENCE TOOLS

Research and reference tools include electronic versions of encyclopedias, atlases and mapping tools, and dictionaries and thesauruses. A summary of these, with sample products and classroom uses, is shown in Table 6.



**TABLE 6** Overview of Research and Reference Tools

Tool Category	Example Software Tools	Purposes and Benefits
Online encyclopedias	<ul style="list-style-type: none"> <li>• <i>Encyclopedia Britannica</i> http://www.britannica.com</li> <li>• <i>Encyclopedia.com</i> http://www.encyclopedia.com</li> </ul>	Help students research any topic
Online atlases and mapping tools	<ul style="list-style-type: none"> <li>• <i>Worldatlas</i> http://www.worldatlas.com/aatlas/world.htm</li> <li>• <i>Rand McNally</i> http://www.randmcnally.com</li> <li>• <i>Mapquest</i> http://www.mapquest.com</li> <li>• <i>The National Map</i> (geological) http://nationalmap.gov</li> <li>• <i>U.S. Atlas</i> http://www.nationalatlas.gov</li> <li>• Atlas of the Universe http://www.atlasoftheuniverse.com</li> <li>• Google Maps http://maps.google.com</li> </ul>	Help students learn about and use local, national, world, and extraterrestrial geography
Online dictionaries and thesauruses	<ul style="list-style-type: none"> <li>• Technology words: <i>Webopedia</i> http://www.webopedia.com</li> <li>• Any words/thesaurus: <i>Merriam-Webster</i> http://www.merriam-webster.com</li> <li>• Any words/thesaurus: <i>Dictionary.com</i> http://dictionary.reference.com</li> </ul>	Give definitions and synonyms

## Electronic Encyclopedias

For many years, American families kept sets of encyclopedias to support their children's education. Young people

### FIGURE 6 Sample Screen from the WorldandISchool.com Encyclopedia



Source: Reprinted by permission of the World and I Online.

used these books for research on school projects, and parents used them to take advantage of “teachable moments” when their children required more than quick answers. Now most major encyclopedias come on CD-ROM or on websites with some kind of database structure. (See an example online encyclopedia in Figure 6.) These electronic encyclopedias have several advantages over books: users can search to locate either one specific item or all references on a given topic, and they usually offer multimedia formats that include sound and/or film clips as well as hypertext links to related information on any topic.

## Electronic Atlases and Mapping Tools

Like encyclopedias, atlases are popular educational reference tools for families as well as schools. They summarize geographic and demographic information ranging from population statistics to national products. CD-ROM versions of these atlases are especially helpful because they are so interactive. Students can either see information on a specific country or city or gather information on all countries or cities that meet certain criteria. Some atlases even play

national songs on request! Mapping sites such as MapQuest also help teach geographic concepts by showing distances between points.

## Electronic Dictionaries (Word Atlases)

Sometimes called **word atlases**, electronic dictionaries and thesauruses give pronunciations, definitions, and example uses for each word entry. They also offer many search and multimedia features similar to those of encyclopedias and atlases. Many electronic dictionaries can play an audio clip of the pronunciation of any desired word, which helps young users and others who cannot read diacritical marks.

## USING TOOLS TO SUPPORT SPECIFIC CONTENT AREAS

Numerous content-specific technologies support teaching within a content area. Some of these tools are described within this chapter. Examples of content-area tools are CAD systems; music tools such as music editors, sequencers, and MIDI tools; reading tools; microcomputer-based labs; graphing calculators and calculator-based labs; and Geographic Information Systems and Global Positioning Systems. A summary of these, with sample products and classroom uses, is shown in Table 7.

**TABLE 7** Overview of Content-area Specific Tools

Tool Category	Example Software Tools	Purposes and Benefits
CAD systems	<ul style="list-style-type: none"> <li>• <i>AutoCAD</i> <a href="http://usa.autodesk.com">http://usa.autodesk.com</a></li> <li>• <i>Alibre</i> <a href="http://www.alibre.com">http://www.alibre.com</a></li> </ul>	Students create visual models of houses and other structures as they study design concepts
Music editors, sequencers, and MIDI tools	<ul style="list-style-type: none"> <li>• <i>iLike</i> and <i>Garageband</i> <a href="http://www.ilike.com">http://www.ilike.com</a></li> <li>• Listing of MIDI products <a href="http://www.midi.org">http://www.midi.org</a></li> </ul>	Students create their own musical pieces or revise those of others
Reading tools	<ul style="list-style-type: none"> <li>• Readability calculation software <a href="http://www.readabilityformulas.com">http://www.readabilityformulas.com</a></li> <li>• Accelerated Reader (AR) <a href="http://www.renlearn.com/ar">http://www.renlearn.com/ar</a></li> </ul>	Teacher support reading instruction in various ways
Microcomputer-based labs (MBL), calculator-based labs (CBL), and graphing calculators	<ul style="list-style-type: none"> <li>• Texas Instruments graphing calculators <a href="http://education.ti.com">http://education.ti.com</a></li> <li>• Vernier LabQuest <a href="http://www.vernier.com">http://www.vernier.com</a></li> </ul>	Students collect and analyze data from problems or experiments
Geographic information systems (GIS) and global positioning systems (GPS)	<ul style="list-style-type: none"> <li>• ARCView GIS <a href="http://www.esri.com/software/arcview">http://www.esri.com/software/arcview</a></li> <li>• GPS curriculum <a href="http://www.educaching.com">http://www.educaching.com</a></li> <li>• Magellan GPS <a href="http://www.magellangps.com">http://www.magellangps.com</a></li> <li>• Garmin GPS <a href="http://www.garmin.com">http://www.garmin.com</a></li> </ul>	Students study geographic and social studies information and concepts
Online foreign language dictionaries and language translators	<ul style="list-style-type: none"> <li>• Listing of foreign language dictionaries <a href="http://www.foreignword.com">http://www.foreignword.com</a></li> <li>• WorldLingo <a href="http://www.worldlingo.com">http://www.worldlingo.com</a></li> <li>• Babylon 9 <a href="http://translation.babylon.com">http://translation.babylon.com</a></li> </ul>	Students use these as references in the study of languages other than their native ones

## CAD and 3-D Modeling/ Animation Systems

A **computer-assisted design (CAD)** system is a special kind of graphics production tool that allows users to prepare sophisticated, precise drawings of objects such as houses and cars. Like presentation tools, CAD systems began to appear in classrooms after they had been introduced in business and industry. This kind of software is usually employed in vocational-technical classrooms to teach architecture and engineering skills. However, some teachers use CAD software to teach drawing concepts in art and related topics. (See Figure 7 for an example of CAD software.) More advanced graphics students may use 3-D modeling and animation software systems to do fancy visual effects such as **morphing** (short for metamorphosing, an animation technique in which one image gradually turns into another).

## Music Editors, Sequencers, and MIDI Tools

**Music editor** software provides blank musical staves on which the user enters the musical key, time, and notes that constitute a piece of sheet music. This software is designed to help people develop musical compositions on-screen, usually in conjunction with hardware such as a **Musical Instrument Digital Interface (MIDI)** device, a standard adopted by the electronic music industry for controlling devices that play music (for example, **music synthesizers**). Music editors allow a user either to hear the music after it is written or to create music on the keyboard and automatically produce a written score.

### FIGURE 7 Sample Screen from CAD Software



Source: CadSoft Computer/Autodesk.

**Music sequencers** are software packages that support the creation of music scores with several parts. Music editors offer powerful assistance in the processes of precomposing, composing, revising, and even performing. These tools play a prominent part in the music classroom, but Mishra and Koehler (2009) remind us that they can also be used to teach concepts in other areas, such as using a music editor to analyze music clips and relate math concepts such as ratios and percentages to rhythm, music, and tempo.

## Reading Tools

Both reading teachers and teachers of other topics occasionally need to determine the approximate reading level of specific documents. A teacher may want to select a story or book for use in a lesson or to confirm that works are correctly labeled as appropriate for certain grade levels. Several methods are available for calculating the reading level of a written work; all of them are time consuming and tedious to do by hand. Readability analysis software automates calculations of word count, average word length, number of sentences, or other measures of reading difficulty.

Another software tool related to reading instruction, Cloze software, provides passages with words missing in a given pattern; for example, every fifth word or every tenth word. Students read the sentences and try to fill in the words. Cloze passages have been found to be good measures of reading comprehension. Some teachers also like to use them as exercises to improve reading comprehension.

Many books for children as well as adults are available in interactive versions called interactive storybooks or **electronic storybooks**, which can be read from a computer screen, on mobile devices, or as print books with interactive buttons. Some of these allow children to hear narrations in English or Spanish. Others let children explore the screen, activating animations and sounds when they click in various locations. These books are designed to provide an interesting, interactive way to read and to increase reading fluency. However, Pearman and Chang (2010) remind us that though the features of electronic storybooks can support reading acquisition, they can also distract children's productive reading and should be carefully supervised.

A product called *Accelerated Reader* or *AR* designed to track students' reading skills, has seen popular use. Its purpose is to motivate students to increase the amount of reading they do for enjoyment. It keeps track of the number of books they read and tests them on comprehension. Teachers can get individual or aggregate data on books read at each readability level. This gives them a better idea of how students are progressing in their reading abilities and whether they are spending enough time reading at desired levels. Early studies found that schools using AR for

longer periods of time show higher rates of reading, which may correlate with higher tested reading levels. However, subsequent reviews of research performed by the U.S. Government's What Works Clearinghouse found “no discernible effects in reading fluency and comprehension for adolescent learners” (U.S. Department of Education, 2010, p. 5) and “no discernible effects for reading fluency, mixed effects for comprehension, and potentially positive effects for general reading achievement” for K–3 students (U.S. Department of Education, 2008, p. 4). The What Works Clearinghouse also reviewed research for English Language Learners (ELL), but found that too few studies met criteria to allow it to draw conclusions (U.S. Department of Education, 2009).

## Microcomputer-Based Labs (Probeware)

A technology tool that has proven particularly useful in math and science classrooms is the **microcomputer-based lab (MBL)**, sometimes referred to as **probeware**. MBL packages consist of software accompanied by special hardware sensors designed to measure light, temperature, voltage, and/or speed. The probes are connected to the microcomputer, and the software processes the collected data. Computer-based probeware actually can replace several traditional items of lab equipment, such as oscilloscopes and voltmeters. Brunsell and Horejsi (2010) say that probeware devices are standard equipment for the modern science classroom and have software interfaces with other cutting-edge equipment like digital microscopes, GPSs, and robots. Blanchard, Sharp, and Grable (2009) point out that probeware can also be useful to integrate science and mathematics in authentic and motivating projects. For one such project, see Technology Integration Example 8.



For many years, calculators have played a widespread—and often controversial—role in mathematics education.  
Photo by W. Wiencke.

## Graphing Calculators and Calculator-Based Labs

For many years, calculators have played a widespread—and often controversial—role in mathematics education. **Graphing calculators**, which are software-programmed devices that have small screens and can illustrate equations in graphs, have emerged and have become indispensable tools in both mathematics and higher level science

### TECHNOLOGY INTEGRATION EXAMPLE 8

#### USING PROBEWARE AND GRAPHING CALCULATORS

**TITLE:** Car Lab Project

**CONTENT AREA/TOPIC:** Physical science, mathematics

**GRADE LEVELS:** High school

**NETS FOR STUDENTS:** Standard 4—Critical Thinking, Problem Solving, and Decision Making;  
Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Science and Mathematics; Critical Thinking and Problem Solving: Reason effectively, solve problems; ICT: Apply technology effectively

**DESCRIPTION:** This project, which connects physical science and mathematics skills, builds on teenagers' natural excitement about cars and getting a driver's license. Students are asked to design a rubber-band car that will go the fastest and/or farthest in a drag race. In an initial race, they collect data by placing their car directly in front of a motion detector attached to a graphing calculator. As they race their cars, the graphing calculator displays the velocity graph and slope. The class discusses what a straight versus a curved line means for observations of velocity and acceleration. Students then go to each of four different stations, each of which uses probes and graphing calculators to collect data and create graphic representations for discussion and analysis: (1) Going the Distance (additional speed trials to generate and analyze graphs of velocity and acceleration), (2) Piston Pressure (to experiment with and observe physical principles about pressure in closed systems), (3) The Color of Headlights (experiments with light intensity), and (4) Soda Can Radiator (experiments with energy and temperature).

**Source:** Based on a concept from Blanchard, M., Sharp, J., & Grable, L. (2009). Rev your engines! *The Science Teacher*, 76(2), 35–40.

curricula. Jaqua (2010) describes a variety of classroom activities, appropriate for students from sixth grade up to the college level, that use these devices to teach graphing skills. Browning and Garza-Kling (2010) review four ways graphing calculators can be used to investigate mathematical ideas at the middle school level. Other articles in the special issue of *Mathematics Teaching in the Middle School* (vol. 16, nos. 5–6) offer a wealth of ideas and activities on how to use graphing calculators in teaching algebra and geometry for middle school students. When probes or sensors are connected to a graphing calculator rather than to a computer (as described in the previous section on MBLs), they are called **calculator-based labs (CBLs)** (Brown, 2001).

## Geographic Information Systems and Global Positioning Systems

A **Geographic Information System (GIS)** is a computer system that is able to store in a database a variety of information about geographic locations. After it has stored all the data that describe a given location, the GIS can then display the data in map form. According to Parmenter and Burns (2001), the three primary uses of GISs are (1) to record and maintain large amounts of geographic information; (2) to produce up-to-date, customized maps; and (3) to allow analysis and comparison of information on different locations.

A **Global Positioning System (GPS)** is a worldwide radio-navigation system made possible by a bank of 24 satellites and their ground stations. Using satellites as reference points, a GPS unit can calculate positions of anything on earth accurate to a matter of feet or inches. A GPS receiver connected to mapping software is what most people think of as a GPS; however, the use of these systems is growing, from finding your way in an unfamiliar community to guiding farmers as they plant and harvest their crops. These small devices can be useful in a car, agricultural equipment, the home, or even a portable laptop. Though GIS and GPS tools are used primarily in teaching science and social studies, uses for a variety of other content areas have been reported. For example, Gentry (2006) describes their use for topics ranging from economics to health and wellness, and Kremer (2007) tells how they can be used for adapted physical education for high-functioning and visually impaired students. Figure 8 shows children using a GPS in an outside-school learning activity.

## FIGURE 8 GPS Activity in the Field



Global Positioning Systems (GPS) are so portable, they can be used to support field activities like this one in which children are looking for locations to collect data for a science project.

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## Online foreign language Dictionaries and language Translators (Machine Translation)

Two online tools that can support students as they learn additional languages are foreign language dictionaries and language translators, with the latter usually referred to in foreign language education as “**machine translation.**” Online **foreign language dictionaries** function like other dictionaries in that they allow people to look up definitions for words and phrases in common usage. However, foreign language dictionaries allow users to look up a word or phrase in one language (e.g., French or German) and get the definition and synonyms for it in another language (e.g., English). These online tools are used like any quick reference to help students learn and use a language new to them.

**Language translators** work as the name implies: they allow users to input sentences and paragraphs of text in one language and get a translation into another language. In foreign language education, the practice of using these “machine translation” tools is viewed as highly problematic. Williams (2006) points out that such translators often provide literal translations that are not accurate representations of meaning, and students who are new to the language are not able to make judgments about grammar and usage that allow them to judge correctness of translations. Both Williams (2006) and Steding (2009) offer strategies for using these tools in the classroom in ways that best support students’ burgeoning skills.



# SUMMARY

(left to right) © Shutterstock, Fotolia, iStockphoto, Shutterstock

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

**1. Benefits of software tools are:** improved efficiency and productivity, improved appearance, better accuracy and timeliness of information, and more support for interaction and sharing.

**2. Recent developments in software tools**—These include increased use of cell phones and other handheld technologies to access tools, more availability and use of web and cloud storage, and greater availability of software suites, or collections of tools sold in one package.

**3. Materials generators**—These are tools that help teachers and students produce instructional materials. They include desktop publishing software, web design software, whiteboard lesson software, test generators and rubric generators, worksheet and puzzle generators, IEP generators, graphic document makers, and PDF and forms makers.

**4. Data collection and analysis tools**—These are tools that help teachers collect and organize information that indicates student progress. They include electronic gradebooks, statistical packages, online survey systems, student information systems, online and computer-based testing systems, and student response systems (clickers).

**5. Graphics tools**—These are tools that allow the manipulation of images to illustrate documents and web pages. They

include draw/paint programs; image editing tools; charting/graphing tools; and clip art, photo, animation, sound, video, and font collections.

**6. Planning and organizing tools**—These are tools that help teachers and students conceptualize, organize, and communicate their ideas. They include outlining and concept mapping software; lesson planning software; and scheduling, calendar, and time management tools.

**7. Research and reference tools**—These are tools that let students look up information in electronic versions of encyclopedias, atlases, and dictionaries. They include electronic versions of the following tools: encyclopedias, atlases and mapping tools, and dictionaries and thesauruses.

**8. Content-area tools**—These are tools that support teaching and learning activities in various content areas. They include CAD systems, music tools such as music editors and sequencers, reading tools, microcomputer-based labs, graphing calculators and calculator-based labs, Geographic Information Systems and Global Positioning Systems, and online foreign language dictionaries and language translators (machine translation).



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** Some educators object to the use of tools such as test generators and worksheet generators, saying that they encourage teachers to use technology to maintain current methods, rather than using technology in more innovative ways. What case can you make for keeping software tools like these in classrooms?

**2.** The use of online and on-computer testing systems is becoming a popular, albeit controversial, practice (see <http://www.fairtest.org/facts/computer.htm>). What are the main points raised by critics of these systems? How would you address them?

**3.** Online language translators are proliferating, despite the fact they rarely provide completely accurate translations from one language to another. An essay called "Do online translators really work, or are they more trouble than they're worth?" (<http://french.about.com/library/bl-onlinetranslators.htm>) gives examples of these inaccuracies. Since these literal translations can cause problems for students of foreign languages, what is a proper role for these tools in foreign language learning?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you created from one of the Project Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions after it.

*Mr. Emerson is a ninth grade mathematics teacher who came into teaching as a second career after working for many years as an accountant. This is his second year as a teacher. He feels confident in his grasp of applied mathematics concepts, but sometimes has to review algebra and other topics before teaching them; these also seem to be the ones that present most problems for his students. Despite this, he is viewed as a successful teacher, and a majority of his students like his classes and make good grades. However, because of the increasing emphasis on student and teacher accountability as measured by high-stakes tests, he realizes that his success will be evaluated by his students' scores on the state's end-of-course test coming up at the end of the month. He wants to make sure his students are ready for the test, so he is looking for ways of helping them review. One of his math-teacher colleagues told him about interactive whiteboard activities that use game formats such as Jeopardy for practicing math concepts. His colleague says his students find them very*

engaging and motivational and they work well to review for tests. Mr. Emerson has an interactive whiteboard in his room, but he uses it primarily to project his PowerPoint illustrations. He would like to find ways to use whiteboard activities for an interactive and engaging test review.

- a. Deconstruct Mr. Emerson’s Tech-PACK in the following way. Fill in the following matrix to show what he knows and what he will have to learn in terms of content, technologies, and pedagogies in order to be in his Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that he must address to implement this new strategy effectively in his classroom.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological,

pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.
- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology



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.



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# **HYPERMEDIA TOOLS FOR 21ST CENTURY TEACHING**

# HYPERMEDIA TOOLS FOR 21ST CENTURY TEACHING

Students today are growing up in a digital world. These “digital natives” learn in new and different ways, so educators need new approaches to make learning both real and relevant for [them].

Marc Prensky, *Teaching Digital Natives: Partnering for Real Learning* (2010a)

## o u t c o m e s

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

1. Define hypermedia from historic and current perspectives.
2. Create and communicate a rationale for developing and using hypermedia products that is based on past research on the impact of hypermedia and hypermedia’s current classroom roles.
3. Develop instructional activities that make best use of the hypermedia features and capabilities of interactive presentation software.
4. Develop instructional activities that make best use of the hypermedia features and capabilities of video-based products.
5. Develop instructional activities that make best use of the features and capabilities of hypermedia programming software.
6. Develop instructional activities that make best use of the hypermedia features and capabilities of virtual environments.



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## key terms

aptitude-treatment interaction (ATI)  
Audio Video Interleave (AVI) format  
avatars  
cognitive overload

electronic slide shows  
essential processing  
EXtensible Markup Language (XML)  
extraneous processing  
full immersion systems

generative processing  
haptic interfaces  
head-mounted display (HMD)  
hypermedia  
hypertext



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# TECHNOLOGY INTEGRATION IN ACTION: LET ME SHOW YOU WHAT I MEAN: PERSUASIVE BIOETHICS VIDEOS

GRADE LEVELS: 7-8 • CONTENT AREA/TOPIC: Science, language arts, ethics • LENGTH OF TIME: Three weeks

## PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

### Step 1: Determine relative advantage.

Ms. Oliphant is a seventh grade teacher who teaches both language arts and science in separate periods, like most other

subjects that are taught in school. She feels that, as a result, students fail to see how integrated topics like these truly are in the “real world.” She had also been reading in her professional journals about 21st Century Skills that focus on creativity and higher-level problem solving. Since she teaches science and language arts to the same students each day, she had an idea for a cross-curricular unit that would help students take charge of their learning and problem solving in a meaningful and fun way and would teach them a variety of ways to persuade and convince in writing. In science, students would use videos and Internet materials to learn about and research ethics and biotechnology concepts, but they would demonstrate their knowledge in traditional persuasive essays. Then, in language arts they would use movie editing software to create short videos that focused on a biotechnology ethical issue of their choice. This project would give them a chance to flex their creative muscles while learning how to absorb and communicate information on a complex topic in both written and visual formats.



Source: The President’s Commission on BioEthics, <http://www.bioethics.gov>

### Step 2: Assess Tech-PACK.

**Content and Pedagogical Domains.** Ms. Oliphant had taught science and language arts in middle schools for 15 years and felt

interactive or electronic storybooks  
Moving Picture Experts Group (MPEG) format  
multimedia  
podcast

QuickTime movie (MOV) format  
QuickTime VR Authoring Studio  
screenagers  
storyboard  
video editing software

video sharing  
virtual manipulatives  
virtual reality (VR)  
Virtual Reality Modeling Language (VRML)  
vodcast

Voice Extensible Markup Language (VXML)  
webcam



© Fotolia

she had a good basic grounding in science and language arts content. She was an award-winning teacher and was thought of as a role model for innovative teaching. Despite that, she always felt challenged to learn new and better ways to help students develop their writing skills, so she went to as many workshops as she could on teaching writing and was always looking for teaching tips and strategies to improve her teaching. She also knew she had to keep up with developments in bioethics, so each time she taught the topic, she consulted a set of sources on current developments in the area.

**Technology Domain.** For several years, Ms. Oliphant had been using Discovery Education's streaming video library and Internet sources to teach science topics and had learned how to help her students load these materials onto iPods for easy access. And, though she could use a video camera, she hadn't used video editing software since her college days. She began brushing up on the software and on how to download clips from the video camera or from the video library. She also knew she would have a learning curve for how to make use of video for persuasive purposes. She had a colleague in the school who was expert in this area, so she tapped his expertise.

## INTRODUCTION TO HYPERMEDIA CONCEPTS

We live in a multimedia world, surrounded by complex images, photographs, video, and audio. So perhaps it is not surprising that part of our human evolution has focused on making our technology reflect the color and clamor of our surroundings. In educational technology, multimedia has been a steadily growing presence for some time. Computer-based multimedia learning stations have been used since 1966, and non-computer multimedia methods have been around even longer. This chapter examines current

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Ms. Oliphant was very sure of the skills and attitudes she wanted students to take away from this project, but she knew she would have to create good assessments matched to these skills and attitudes in order to measure the project's success. The outcomes, objectives, and assessments she decided on were as follows:

- » **Outcome:** Write a persuasive essay on a bioethics issue.  
**Objective:** At least 80% of students will achieve 90% on a written essay that takes a position on a bioethics issue and aims to persuade readers to adopt the position. **Assessment:** Rubric to assess bioethics content knowledge and writing skills.
- » **Outcome:** Create and present a persuasive video on a bioethics issue. **Objective:** At least 90% of students will achieve 90% on a video that uses visuals to communicate a specific position on a bioethics issue and aims to persuade the audience to adopt the position. **Assessment:** Rubric to assess bioethics content knowledge, video presenting skills, and technical skills.

### Step 4: Design integration strategies.

Ms. Oliphant planned for the project to last three weeks. She designed the following sequence of activities to be done in the science and language arts class periods each day.

- » **Days 1-2: Introduce the unit and begin work.** The teacher introduces the topic of bioethics with examples and explains the two products the students will do. She shows an illustrative persuasive essay and video and shows students how to download video clips and Internet materials onto iPods for easy access.
- » **Days 3-4: Work on research and writing skills.** In science, students begin researching bioethics issues and thinking

classroom uses of electronic multimedia and the concept that grew out of it, hypermedia.

## Definitions of Multimedia and Hypermedia

Definitions of multimedia and hypermedia were initially separate, but they have converged over time.

- » **Multimedia** literally means "multiple media" or "a combination of media." The media can be still graphics and photographs, sound, motion video, animation, and/or

about which one they would like to work on. In language arts, they learned how to gather and assess facts and opinions from video and written sources and how to take notes on videos as they watch them. The teacher facilitates their work.

- » **Day 5: Final topic selection.** In science, the students present their initial ideas and the teacher facilitates a discussion about them to help them make a final decision on topic and approach.
- » **Days 6–10: Student work on essays.** As students complete their essay outlines and drafts, they discuss them with the teacher. Students turn in final draft essays at the end of the week.
- » **Days 11–16: Student work on scripts.** Students work on compiling materials and writing scripts. The teacher facilitates their work, reviewing draft scripts as they work on them. Scripts must be approved before final production can begin, but students do preliminary work on videos.
- » **Days 17–19: Student work on videos.** Students complete their videos, working on them during the two class periods.
- » **Days 19–20: Presentations.** Students present and discuss their videos.
- » **Post-unit activity.** The teacher posts the videos on a school website so that parents and others can view them.

### Step 5: Prepare instructional environment.

Ms. Oliphant did the following tasks to prepare for the project:

- » **Prepare for iPod use:** She prepared handouts and a teaching sequence on how to download video and Internet files to iPods. She also scheduled iPods for check-out from the library for students who didn't already have a handheld device where they could store media files.
- » **Obtain video cameras:** She checked out two cameras with video capability from the school library to use during the project.

text items combined in a product whose purpose is to communicate information in multiple ways.

- » **Hypermedia** refers to “linked media” or “interactive media,” terms that have their roots in a concept developed by Vannevar Bush in his landmark article, “As We May Think.” In 1945, Bush proposed a “memex” machine that would let people quickly access items of information whose meanings were connected but that were stored in different places. In the 1960s, Ted Nelson coined the term **hypertext** to describe a proposed database system, called Xanadu, based on Bush's idea (Boyle, 1997). In this system, items of information

- » **Movie editing software:** She obtained movie editing software from the school's technology coordinator and placed it on her classroom computers. She also made sure the same software was available in the library media center, so students could work there if they needed to work on projects after class.
- » **Prepare rubrics:** She created the required assessment rubrics and uploaded them to her classroom website so that students could see them whenever they liked and/or make their own copies of them.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

The first time Ms. Oliphant taught the project, she was pleased that almost all of her students had achieved at least a 90% rubric score on their videos. However, only about 50% of the students met the desired criterion on the written essays. She realized the low scores on grammar, punctuation, and mechanics were usually to blame. She was delighted, however, that students had clearly become immersed in the research and discussions about bioethics issues and that she and the students had gotten many positive comments from teachers, parents, and other students about their posted videos. The principal asked her to make a presentation about the project at the next PTO meeting.

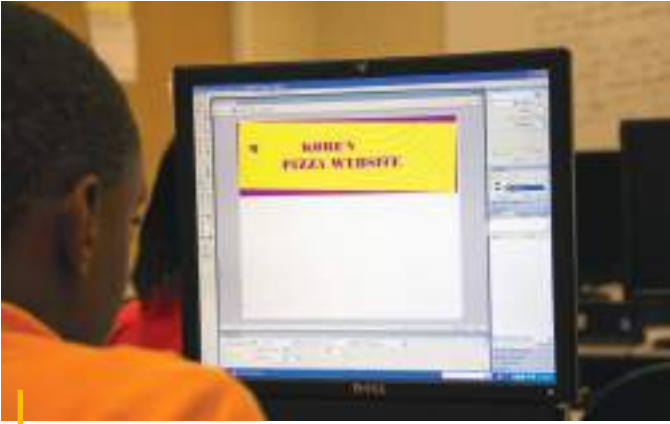
### Step 7: Make revisions.

Ms. Oliphant knew she would have to allow more time for instruction on “common mistakes” she was seeing in the papers, as well as more time for review and revisions of the written essays. She also thought she would try having students critique each other's papers for grammar, mechanics, and punctuation.

**Source:** Based on a concept from Karim, G. (2008). Making meaning across the curriculum. *Learning and Leading with Technology*, 36(2), 31–32.

from all over the world were to be logically connected with hypertext links. For example, one could select “apple” and get information on all related concepts, such as trees and fruit—even the Garden of Eden. The technology at that time was inadequate to produce Xanadu, but the idea was the forerunner of today's hypermedia systems in which information stored in various media are connected (often via the Internet)—thus the term **hypermedia**.

In current technologies, such as Internet browsers and design/development software packages, most multimedia



Multimedia and hypermedia authoring tools can help students generate new and different perspectives on organizing and presenting information.

Photo by W. Wiencke.

products are also hypermedia systems. That is, contemporary media elements are linked together by buttons and navigation menus and often exist as components in a larger, immersive environment. Clicking on or selecting one item sends the user to other, related items. Even video resources are becoming linked to other information on the Internet through keywords.

This chapter provides many examples of hypermedia products; all are also multimedia. The combination of media such as video and audio with text makes them multimedia; the ability to get from one media/information element to another makes them hypermedia. It is important to note that the term multimedia has become somewhat of an overarching descriptor for most Internet-based media, interactive or static (i.e., a linear, fixed progression of content). In order to preserve the term's use throughout the cited references, subsequent discussion in this chapter will refer to them as hypermedia.

## Types of Hypermedia Systems

Hypermedia systems come in a variety of hardware, software, and media configurations and, until recent years, were usually classified according to their primary storage equipment: interactive videodiscs, CD-ROMs (compact disc-read-only memory), digital versatile discs (DVDs). However, dramatic changes in the capabilities of presentation software, hypermedia design and development tools, and Internet media formats have changed the focus of this classification system from the delivery medium to the development platform and to the type of capability the products offer.

This chapter focuses on the following five hypermedia formats:

1. Commercial hypermedia software packages,
2. Interactive presentation software,

3. Audio/video production and editing systems,
4. Hypermedia design and development programs, and
5. Virtual environments.

The first of these categories represents products developed by companies and sold to educational consumers. The other four are design and development tools (or software packages) that educators and others can use to create their own hypermedia products. The next section will review the first of these hypermedia types: commercial hypermedia products.

## Types of Commercial Hypermedia Products

The increased storage capability and availability of CD and DVD media have made it easier to store complex programs with motion graphics, movies, audio, and links to the Internet. Several types of commercial hypermedia products are also readily available, including instructional software (e.g., tutorials, drills, simulations), interactive books, reference materials, and collections of development materials. Additionally, Internet bandwidth connection speeds are increasing at a rapid rate in homes and school districts, allowing designers to incorporate CD- and DVD-quality video and multimedia artifacts on the web. Examples of commercial hypermedia and multimedia are discussed here and summarized in Table 1.

**Instructional software.** Once primarily text-based, instructional software materials now usually have an extensive assortment of hypermedia features with broadcast-quality multimedia content. Hypermedia features have increased the capability and value of these programs. For example:

- » **Tutorials**—Descriptions and explanations can be visual in nature and can be presented with screen capture videos (i.e., video recordings of another user's screen when demonstrating a task), with digitized video played in the browser, spoken to the student through use of audio files, and/or presented in text format with supportive imagery.
- » **Drill and practice**—Practice items can be posed in audio or video, as well as text, and feedback for correct and incorrect answers can be presented in any combination of these modes.
- » **Simulations**—Because multimedia presentations can include movement and sound, simulations can be even more realistic than textual narratives and imagery of a concept or context.
- » **Instructional games**—Motion and sound can make presentations more attractive and can further enhance the motivational qualities of games.

**TABLE 1** Summary of Categories of Commercial Hypermedia Products

Tool Category	Example Software Tools	Description
Instructional software	<ul style="list-style-type: none"> <li>• <i>Tutorial Finder</i> <a href="http://www.tutorialfind.com">http://www.tutorialfind.com</a></li> <li>• <i>IKnowThat</i> interactive instructional software <a href="http://www.iknowthat.com/com">http://www.iknowthat.com/com</a></li> <li>• <i>Rosetta Stone</i> language software <a href="http://www.rosettastone.com">http://www.rosettastone.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Tutorials</li> <li>• Drills</li> <li>• Simulations</li> <li>• Instructional games</li> <li>• Problem solving</li> </ul>
Interactive or electronic storybooks	<ul style="list-style-type: none"> <li>• Living Books <a href="http://www.classsource.com/livingbooks">http://www.classsource.com/livingbooks</a></li> <li>• <i>U-Ventures</i> <a href="http://www.u-ventures.net">http://www.u-ventures.net</a></li> </ul>	<ul style="list-style-type: none"> <li>• Online or CD-based materials</li> </ul>
Reference materials	<ul style="list-style-type: none"> <li>• <i>Encyclopedia Britannica</i> <a href="http://www.britannica.com">http://www.britannica.com</a></li> <li>• <i>Encyclopedia.com</i> <a href="http://www.encyclopedia.com">http://www.encyclopedia.com</a></li> <li>• <i>New York Times</i> <a href="http://www.nytimes.com">http://www.nytimes.com</a></li> <li>• <i>The Old Farmer's Almanac</i> <a href="http://www.almanac.com">http://www.almanac.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Encyclopedias</li> <li>• Newspapers</li> <li>• Almanacs</li> </ul>
Collections of development resources	<ul style="list-style-type: none"> <li>• Graphics for Teachers <a href="http://www.teachingheart.net">http://www.teachingheart.net</a></li> <li>• Microsoft Media Collections <a href="http://office.microsoft.com/en-us/images/">http://office.microsoft.com/en-us/images/</a></li> <li>• Shutterstock Photos <a href="http://www.shutterstock.com">http://www.shutterstock.com</a></li> <li>• <i>Digital Sound Factory</i> (musical instruments) <a href="http://www.digitalsoundfactory.com">http://www.digitalsoundfactory.com</a></li> <li>• <i>Flaming Text</i> <a href="http://www.flamingtext.com/">http://www.flamingtext.com/</a></li> <li>• Adobe Fonts Collection <a href="http://www.adobe.com/type/collections.html">http://www.adobe.com/type/collections.html</a></li> <li>• Animation Factory <a href="http://www.animationfactory.com">http://www.animationfactory.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Clip art</li> <li>• Photos</li> <li>• Sound clips</li> <li>• Fonts</li> <li>• Animations</li> </ul>

» **Problem solving**—Problems may be presented to learners in video format, thus clarifying the problems to be solved and demonstrating visually the relationship among the items of information required for solution generation.

**Interactive or electronic storybooks.** Stories that can be read from a computer screen, on mobile devices, or as print books with interactive buttons are called either **interactive storybooks** or **electronic storybooks**. All these formats have become extremely popular and uses have been reported with groups from primary teachers and students to toddlers. With online or CD versions of these stories, reading can be done in several ways. In some, narrators read pages as the words are highlighted on screen for the learner. If a student needs to hear a word again, just clicking on it activates the audio. Some online interactive storybooks allow students to read them at their own pace, with interaction available as the

student requests it. This genre was made popular by Edward Packard (Conan, 2010) in print books in the *Choose Your Own Adventure* series, some of which Packard later transferred to app form and can be downloaded from *iTunes*. An example of these interactive books, called *U-Ventures*, is shown in Figure 1. Some of the online stories are structured to be more open-ended, allowing students to choose the story path and to end where they want each time the story is read. Various studies have reported positive impact of interactive storybooks on children's enjoyment of reading and development of reading skills (Grimshaw, 2007; Korat, 2010; Segal-Dori, Korat, Shamir, & Klein, 2010).

**Reference materials.** Many reference materials are available on CD and DVD at very reasonable cost; in addition, there is increased availability of reference materials on the Internet for little to no cost. These materials include encyclopedias, almanacs, atlases, newspapers, and conference



## FIGURE 1 Example Interactive Book from Edward Packard's *U-Ventures*<sup>®</sup> Series



Source: <http://www.u-ventures.net>. Courtesy of Edward Packard.

proceedings. To add still more value, these resources are accompanied by search tools that make searching for information in the application both easy and efficient. Some materials have simulations, animations, videos, and/or Internet links to still more material.

**Collections of development resources.** Many collections of resources used to develop multimedia are available on CD-ROM and the Internet. These include collections of clip art, sound effects, photographs, flowcharts, concept maps, video clips, fonts, animations, and document templates.

## Current and Future Impact of Hypermedia on Education

The current widespread educational use of hypermedia systems appears to be fulfilling predictions that classrooms of the future will be increasingly multimedia environments. Educators recognize and use these systems when they see the powerful capabilities they offer to enhance classroom learning.

- » **Increased motivation**—Hypermedia programs offer such varied options that most people seem to enjoy using them. Students who usually struggle to complete a project or term paper often will tackle a hypermedia project enthusiastically. Many educators believe the most important characteristic of hypermedia is its ability to encourage students to be proactive learners.

- » **Flexible learning modes**—Hypermedia programs can draw on such diverse tools that they truly offer something for students who excel in any of what learning theorist Howard Gardner calls “intelligences” (1989). For example, a student who may not be good at written expression but has visual aptitude can document learning with video or pictures.
- » **Development of creative and critical thinking skills**—The tremendous access to hypertext and hypermedia tools opens up a multitude of creative avenues for both students and teachers. Creation of hypermedia products requires that the learner constantly make decisions and evaluate progress, thus encouraging students to apply higher order thinking skills. Brown (2007) suggested that multimedia design is a complex and generative activity for learners and supports the development of metacognitive skills, problem-solving strategies, creative freedom, and self-awareness of individual learning styles under demanding project-based conditions.

## Research on Hypermedia Systems

The increasing popularity of hypermedia in education has also made it a popular topic with researchers. Scheiter and Gerjets (2007) observed that much of the initial excitement with these materials focused on their ability to make possible a highly interactive, learner-controlled environment. They point out that this seemed a reasonable initial hypothesis since hypermedia environments are thought to “(1) mirror the human mind, (2) increase interest and motivation to learn, (3) enable instruction adapted to learners’ preferences and cognitive needs, (4) provide affordances for active and constructive information processing, and (5) foster the acquisition of self-regulatory skills” ( p. 301). However, after a review of research to date, Scheiter and Gerjets also had to conclude that the very richness and complexity of these environments have made it challenging to validate these initial hypotheses.

Instead, most hypermedia studies have focused on two lines of research: (1) characteristics of hypermedia that serve to increase or inhibit student achievement, and (2) the impact of hypermedia on student engagement. Summary findings from these studies will be reported here.

**Characteristics of hypermedia systems that promote learning.** Early analyses of research on hypermedia benefits were promising (Liao, 1999; Roblyer, 1999), though Liao’s meta-analysis found that results were mixed and depended on the type of instruction used in the comparison. In light of the variety represented among hypermedia environments, it seemed more productive to focus on when—rather than whether—hypermedia had greater impact on learning.

The work of Richard Mayer and his associates, carried out over a 20-year period, was based on a cognitive theory of multimedia learning and has resulted in a set of evidence-based guidelines for designing optimal hypermedia environments (see especially Mayer, 2008; Moreno & Mayer, 2007). The cognitive theory “explains how people learn from a combination of words (such as printed text or spoken text) and pictures (such as illustrations, photos, charts, animation, or video)” (Veronikas & Shaughnessy, 2005, p. 180). Derived from research in cognitive science, the cognitive theory is based on assumptions that people have separate channels for processing visual and verbal information and are able to process only a few elements in each channel at any one time. It also posits that meaningful learning occurs “when learners engage in appropriate cognitive processing during learning, such as selecting relevant information, mentally organizing the selected information into coherent pictorial and verbal models, and integrating them with each other and with prior knowledge” (Veronikas & Shaughnessy, 2005, p. 180).

Much of Mayer’s research focused on ways to structure environments to maximize these “productive processes” without causing **cognitive overload** or presenting information

in a way that overwhelms the capacity of the learner’s information processing system. These studies yielded design guidelines of three kinds:

- » **How to reduce extraneous processing**—This is mental activity that uses cognitive capacity but does not help the learner learn. Mayer refers to these as the principles of coherence, signaling, redundancy, spatial continuity, and temporal continuity.
- » **How to manage essential processing**—When material is highly complex, the demands of processing it can overwhelm the learner. Strategies for helping the learner handle this processing include segmenting, pre-training, and modality.
- » **How to foster generative processing**—Generative processing, or productive, engaged learning, occurs more often when designs include multimedia and personalization.

All these principles are summarized in Table 2, along with their implications for design. According to Mayer’s research, people learn better when hypermedia materials reflect these principles. Finally, Mayer points out that it

**TABLE 2** Overview of Hypermedia Design Principles Derived from Mayer (2008)

Principles	Explanation
<b>Design principles to reduce extraneous processing</b>	<b>Reducing the need for mental activity that is not directly related to learning the desired information</b>
• Coherence principle	• Omit non-essential information from screen when possible.
• Signaling principle	• When non-essential information must be included, highlight essential information on screen through techniques such as headings or vocal emphasis.
• Redundancy principle	• Provide narration and animation without additional explanatory text on the screen.
• Spatial continuity principle	• Design screen so that text is close to the image it explains. For complicated processes, break them into separate images, each with accompanying text.
• Temporal continuity principle	• Present narration and animation concurrently rather than one following the other.
<b>Design principles to manage essential processing</b>	<b>Helping the learner manage the difficulty of learning complex information</b>
• Segmenting	• Present a narrated animation in learner-controlled segments rather than as one long presentation.
• Pretraining	• Precede a narrated animation on a complex system (e.g., how a car brake works) with an explanation of the names and characteristics of the system’s components.
• Modality	• Present graphics with spoken explanation rather than with printed text.
<b>Design principles to foster generative processing</b>	<b>Encouraging productive, engaged learning</b>
• Multimedia	• Use a combination of words and pictures—this encourages more engagement than words alone.
• Personalization	• Present narration in conversational style rather than formal style.

is important to note ideas about hypermedia that, though popularly hypothesized and researched, have seen limited results in hypermedia studies. These are learning styles research and transfer of skills learned in hypermedia environments (Veronikas & Shaughnessy, 2005). Mayer notes that research has yielded no evidence that preferred formats (e.g., words vs. pictures) in online hypermedia environments have any impact on achievement. The only factor that has been found to affect achievement in these studies is prior knowledge, which demonstrates an **aptitude-treatment interaction (ATI)**. That is, formats that are beneficial for one group have a negative impact on a group with the opposite characteristic (in this case, groups of learners with greater and lesser skill in the content). In their review of decades of learning styles research, Pashler, McDaniel, Rohrer, and Bjork (2008) reach the same conclusion as Mayer: students' preferred styles have no impact on their achievement. Pashler et al. also note that "our intuitions and beliefs about how we learn are often wrong in serious ways" (p. 117), a finding supported by Clark's 1982 research, which showed that people frequently learn least from formats they most prefer.

Mayer also notes that research does not confirm automatic transfer of skills from hypermedia environments, such as video games, to other areas. There is evidence, however, that some kinds of skills may transfer to content area knowledge if teachers and students engage in reflection activities, such as discussion, after such games. In other words, instruction is still necessary after the games; skills do not transfer automatically.

**Impact of hypermedia systems on student engagement.** The other focus for hypermedia studies has been on student attitudes. Although student learning from hypermedia varies based on the design of the materials, students' willingness to engage and persist in instruction is also an important consideration. Students who enjoy instruction are more likely to focus more attention on it. Several studies of hypermedia impact on attitudes look at *PowerPoint* presentations, primarily in higher education settings, and findings are generally positive. For example, Nouri and Shahid (2005) found that students in course sections in which instructors used *PowerPoint* presentations reported that instructors were more informed, effective, and prepared than instructors in other sections. Also, Tang and Austin (2009) found that both video and *PowerPoint* media increased measures of enjoyment and motivation to learn, and that higher course evaluations were also associated with instructors who used these technologies.

However, Mandernach (2009) found that though qualitative comments about hypermedia were usually quite positive, quantitative data revealed that more hypermedia was not necessarily better. She found no differences in attitudes

among the various levels of hypermedia inclusion. She urged designers and future researchers to "examine carefully the cost-benefit ratio of multimedia inclusion for online learning environments" (p. 1).

## Recent Developments in Hypermedia Systems

The following trends in hypermedia system use in education are evident:

- » **Convergence of offline (disc) and online (Internet) development**—Because of the migration to Internet-based delivery for most hypermedia and multimedia instructional products, educators and researchers currently view hypermedia and online web pages as synonymous.
- » **Increasing ease of use**—Hypermedia and multimedia development used to be a fairly technical enterprise, and there are still some software tools that are challenging to use. However, thanks to user-friendly design and development systems (e.g., interactive *PowerPoint*, Apple *iMovie* and *Windows Movie Maker*) in addition to photography and graphics software tools (e.g., Apple *iPhoto*, Adobe *Photoshop Elements*), the development of all forms of hypermedia and multimedia from presentation software to video production has become accessible to nontechnical teachers and students. This user-friendly trend will likely continue, with future versions of existing software and the development of new hypermedia and multimedia development suites entering both corporate and educational realms.

## OVERVIEW OF HYPERMEDIA DESIGN AND DEVELOPMENT

One of the most amazing things about how hypermedia systems have evolved is that people with fairly nontechnical skill levels now can develop complex, professional-looking hypermedia products. Perhaps most importantly for schools, hypermedia authoring may play a major role in preparing students for the information-intensive and visually oriented world of the future. In today's digital world, powerful personal computers and ubiquitous electronic networking allow people to incorporate a variety of media into their communications. Indeed, hypermedia publishing may eventually supersede paper publishing in importance and impact; moreover, the students in today's classrooms will be on the forefront of this succession, both in use and development. Four kinds of multimedia/hypermedia

design and development tools, for use by both teachers and students, are:

- » Interactive presentation hypermedia
- » Audio/video production and editing systems
- » Hypermedia production software
- » Virtual environments

Although these systems vary in capability, sophistication, and authoring procedures, all of them allow users to summarize and display information and knowledge using a combination of text, video, animation, music, graphics, and sound effects. The skills and resources that teachers need in order to use any of these authoring tools, as well as integration strategies that make use of hypermedia formats, are described next. Also, see popular hypermedia strategies in the Top Ten feature and how to make hypermedia most useful for students with special needs in the Adapting for Special Needs feature.

## Multimedia and Hypermedia Authoring Resources

Over time, hypermedia programs have become increasingly more powerful and user-friendly, and features and capabilities are being added with every new version released. Authors now can draw on a wide variety of resources to put a full range of sound and motion in their multimedia/hypermedia products. One useful feature available in hypermedia authoring is the ability to insert Internet URLs

into products as links. Users can click on these links and go immediately from the software screen to an Internet site. Hypermedia resources include audio, video, photographs, graphic images, and text. Table 3 summarizes sources of multimedia/hypermedia authoring materials under each of these categories.

**Audio resources.** Hypermedia authoring programs offer users a number of ways to incorporate audio clips. These include audio from CD, recording sounds, and pre-recorded sounds.

**Video resources.** Motion video clips can add a new and engaging dimension to a software application or website and provide authors with a wide assortment of communication possibilities. As with audio resources, authors have several options for incorporating video displays into a product, including digitized and pre-recorded videos as well as video captured from a live **webcam**, which is a video camera that is connected to a computer in order to gather video for viewing at other locations.

**Photographs.** As in other settings, in hypermedia a picture is worth a thousand words. Photographs provide a powerful resource for authors in all subject areas, not only to enhance but also to amplify the messages communicated to learners. Photos can be scanned, captured from video, taken with digital cameras, imported from a CD-ROM, or downloaded from a stock photography website.

**Graphic images.** Graphic elements, drawings, charts, and animations offer other tools for authors to communicate



## ADAPTING FOR SPECIAL NEEDS

### Multimedia/Hypermedia

**S**ince multimedia materials use communication channels that employ specific senses, multimedia that does not have an accessible alternative can be a major obstacle to individuals with impairments to vision or hearing. Access to multimedia and hypermedia has been an area of considerable advocacy for the disability community.

Designers of accessible multimedia will provide alternative content for video that includes both captions for spoken word and auditory descriptions that are synchronized with the relevant action taking place on the screen. To create an alternative for audio, it is necessary to provide a text transcript of the spoken audio. The text transcription can be provided in HTML format or in a downloadable text file. Rather than listening to the content of the audio file, users will read the transcript as they would any other text content.

The following sites give information, tools, and guidelines on how to design accessible multimedia:

- » Accessible Multimedia (<http://www.doit.wisc.edu/accessibility/online-course/standards/multimedia.htm>)
- » The Comprehensive Guide to Creating Accessible Multimedia for e-Learning (<http://www.skillsforaccess.org.uk>)
- » National Center for Accessible Media (<http://ncam.wgbh.org>)

**Based on** Hoffman, B., Hartley, K., & Boone, R. (2005). Reaching accessibility: Guidelines for creating and refining digital learning materials. *Intervention in School and Clinic, 40*(3), 171-176.

Contributed by Dave Edyburn

**TABLE 3** Summary of Hypermedia Design and Development Resources

Types of Resources	Items of Each Type	Instructional Roles in Multimedia Products
<b>Audio</b>	<ul style="list-style-type: none"> <li>• CD audio—Digitized music, speech, or sound effects captured from audio CD or video DVD</li> <li>• Recorded sounds—Voice recordings</li> <li>• Prerecorded sounds—From collections of sound effects offered in multimedia software or from CD-ROM collections</li> </ul>	<ul style="list-style-type: none"> <li>• Background music for presentations</li> <li>• Illustrations of musical types</li> <li>• Portions of famous speeches</li> <li>• Readings of poetry</li> <li>• Directions to students</li> <li>• Sound effects to add interest or humor or to signal transitions</li> <li>• Teacher and student generated podcast audio files</li> </ul>
<b>Video</b>	<ul style="list-style-type: none"> <li>• Digitized videos—Imported from DVD or VCR using video digitizer, or from camcorder and edited with movie software (e.g., Apple <i>iMovie</i>, Windows <i>Movie Maker</i>)</li> <li>• Collections of prerecorded video clips—Available on CD-ROM or DVD</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrations of procedures (e.g., labs, sport movements)</li> <li>• Recorded lectures</li> <li>• Illustrative examples of topics being discussed</li> <li>• Video decision-making simulations</li> <li>• Video problem-solving situations</li> <li>• Screen capture video for software demonstration</li> </ul>
<b>Photographs</b>	<ul style="list-style-type: none"> <li>• Scanned photos—Digitized from print photographs using scanners</li> <li>• Captured from video sources—Freeze-frames from DVD or VCR</li> <li>• Digital camera images—Downloaded from camera to computer</li> <li>• Commercial collections—From CD-ROM and stock photography collections</li> </ul>	<ul style="list-style-type: none"> <li>• Historical events, documents, or famous people</li> <li>• Geographical locations or objects in outer space</li> <li>• Illustrative tools (e.g., machines or art implements)</li> </ul>
<b>Graphic images</b>	<ul style="list-style-type: none"> <li>• Created or imported—Using draw/paint software, from clip art collections, or images scanned from drawings or hard copy images</li> <li>• Animations—From CD-ROM collections or created using animation tools</li> </ul>	<ul style="list-style-type: none"> <li>• Illustrative cartoons (e.g., political)</li> <li>• Attention-getting cues</li> <li>• Introductory animations for websites and software</li> <li>• Charts and visualizations</li> </ul>
<b>Text</b>	<ul style="list-style-type: none"> <li>• Entered by author—Typed into product or added as a graphic item (e.g., Apple <i>iWork</i>, Microsoft <i>Office</i>)</li> <li>• Imported—From word processing files and graphic design software</li> </ul>	<ul style="list-style-type: none"> <li>• Signs or titles</li> <li>• Summaries of written procedures or explanations</li> <li>• Definitions</li> </ul>

their ideas through visual means. Illustrations can demonstrate or support a point that may be difficult to express with text alone. This aspect of hypermedia authoring is particularly appealing to artistically inclined users. Images can be created by authors, imported from clip art collections, scanned from hard copy, or imported from CD-ROM and online stock photography collections. In addition, animations can be created with animation software. With the ever-increasing capability to search for and download images from the Internet, it is important to stress with students

the principles of fair use so that they become aware of the need to cite their resources and avoid potential copyright infringement (especially as they move forward in their academic and professional careers).

**Text.** Despite the attention paid to other components of hypermedia, text remains one of the most powerful ways to communicate ideas. Text can be generated as a multimedia project develops or can be imported from word-processed files.



The best kinds and uses of hypermedia depend on the content area and skills teachers need to address. The ten uses given here reflect some of the most powerful and popular uses described in the literature.

SOURCE	TRACK	SELECTION
Interactive storytime	<b>1</b>	Use or create online interactive storybooks to support and enhance student's reading skills and to reinforce emerging literacy skills for English Language Learning (ELL) and students learning English as a second or third language.
Jeopardy reviews	<b>2</b>	Use interactive <i>PowerPoint</i> Jeopardy templates to create game-show type reviews of content or to provide skill practice.
Persuasive presentations	<b>3</b>	Students create interactive presentations with <i>PowerPoint</i> or <i>HyperStudio</i> software, using images, charts, and/or video to persuade others of a position they have taken on a controversial issue.
Podcast or vodcast oral histories	<b>4</b>	Students interview local figures or experts to research issues or events, and make and post podcasts or vodcasts of the interviews along with their findings.
Video problem simulations	<b>5</b>	Students use the <i>GeoThentic</i> environment ( <a href="http://lt.umn.edu/geothentic">http://lt.umn.edu/geothentic</a> ) to view videos that pose problems requiring math, science, or geography skills, and view parts of videos again as needed to create solutions.
Film-making across the curriculum	<b>6</b>	Engage students and help them develop digital literacy skills by having them create short films on a topic of study in the classroom. Post finished projects on SchoolTube ( <a href="http://www.schooltube.com">http://www.schooltube.com</a> ) or TeacherTube ( <a href="http://www.teachertube.com">http://www.teachertube.com</a> ).
Videos for visual literacy	<b>7</b>	Give students practice in analyzing video news stories and advertisements to show them how visual images are used to communicate biases and make persuasive arguments.
Student-produced hypermedia history	<b>8</b>	Assign students to work in small groups using web editors and <i>Flash</i> software to create web-based hypermedia mini-documentaries on history topics.
Solar systems in 3-D	<b>9</b>	Students use online, 3-D images of our solar system to learn concepts about the relationships among our planets, sun, and moon.
Virtually-there museum field trips	<b>10</b>	Use or create QTVR panoramas of art museums and other locations with art examples that students would not otherwise be able to see; lead discussions about features that define various artistic genres and artistic periods.



## Hardware and Software Requirements for Hypermedia Design and Development

Although some hypermedia authoring can be accomplished with a fairly minimal computer system, more complex products require additional hardware and software capabilities. Depending on the complexity of the product, some or all of the following hardware resources are needed:

- » **Computer with keyboard, mouse, and monitor**—Hypermedia and multimedia development can be done on any computer platform as long as the system has a hard drive and sufficient internal memory.
- » **Digital cameras**—These cameras let users take digital photographs and store them as digital files. The images then can be incorporated into hypermedia and multimedia projects. Students of all ages enjoy using their own digital photographs in projects. Typically, digital cameras with sensors greater than 5 megapixels are sufficient for use in most classroom projects.
- » **Scanners**—If no digital camera is available, scanners can be used to digitize printed photos so they can be saved to a disc. Scanners also can capture and digitize images from magazines or books.
- » **Video digitizers**—Video digitizers, also known as digitizing boards, are devices that capture full-motion video from video cameras or live TV. The device that provides the video must be connected to the computer via a cable. Once video segments are transferred, they are stored as digitized computer files and can be edited using software, such as Adobe *Premier* and Apple *iMovie*. Both teachers and students should recognize copyright restrictions when digitizing and editing video.
- » **Camcorders and other video input**—Video cameras or camcorders, webcam images, CD-ROMs, and DVDs are possible sources of motion video sequences to include in a hypermedia production.
- » **Microphones**—To incorporate sound, an audio source such as a microphone is needed. Modern computer systems have built-in audio cards, and most new webcams and laptops have built-in microphones.
- » **Audio speakers**—To monitor quality and simply to hear the audio parts of a program, speakers are mandatory for hypermedia development. Many newer computers are shipped with either external or internal speakers. For use in the classroom, individual headphones provide students with privacy and prevent a noisy computer lab.
- » **Software**—The programs needed for hypermedia authoring depend on the type of environment one is developing. These can range from web page editors to a

VRML programming language. Some of these programs can be space-and-memory intensive, so this is a consideration with more complex environments, such as 3-D or immersive products. Some software requires only the use of a website, but works better with a high-speed connection. See the Open-Source Options feature for this chapter for free hypermedia software of various kinds.

## Hypermedia Design and Development Procedures

Whether teachers are developing their own skills or those of their students, the hypermedia authoring process involves two distinct phases. Initially, authors need to learn the mechanics of the programs they plan to use and develop their understanding of the concepts of hypermedia and multimedia. No one can develop a quality product without first being reasonably comfortable with the tools. However, at the next level, hypermedia authors must develop insights into the complexities of the various media and knowledge of visual and navigation design. This is a long-term process that will emerge through a great deal of experience. A number of strategies can aid the classroom teacher in helping students use their time efficiently and focus on developing quality products. Consider the following steps, shown in Figure 2, which students should take when engaging in hypermedia development:

1. **Review existing products**—An effective way of developing authoring and design skills for beginners is to look at what others have done. It is also helpful to examine some effective uses of commercial media; Ken Burns's series on the Civil War (see PBS website: <http://www.pbs.org/civilwar>), for example, demonstrates the power of images and sound when melded together in the context of a story.
2. **Perform research first**—Most hypermedia development projects require research to locate materials and data, analyze the findings, and summarize them in a format for use in the hypermedia product. It is important to allow adequate time for this research phase because it is the heart of the learning activity and ultimately will lead to higher-quality, more informed hypermedia products.
3. **Storyboard**—Storyboarding helps students make good use of their time. On index cards or sticky notes, students can lay out what they want their users to interact with and the necessary content and navigation that must be designed for each section of the hypermedia product. However, planning is the most difficult phase of hypermedia and multimedia development for students; they want to get right to the “fun stuff.” Most

**FIGURE 2** Sequence of Development Steps for Hypermedia Products

students prefer to develop only on the computer. Teachers must insist that on-paper planning be done first. It may help to explain that professional media creators practice storyboarding and that even famous movie directors, such as Alfred Hitchcock and Steven Spielberg, storyboarded entire movies before capturing a single camera shot. This saves time in the long run, and it helps to conceptualize the end result first.

- 4. Develop individual frames and segments**—In the case of hypermedia products using authoring software (e.g., Adobe *Flash*, *HyperStudio*), students should develop each frame or website page, including text fields, before adding links or graphics (e.g., clip art, photos, animations, video, and other media). For video productions, students should shoot video footage in segments as opposed to one long recording. The segments can be edited together at a later time to communicate the story.
- 5. Add links and/or scripts**—For software-authored products, links or buttons should be added last. Most design and development software allows the creator to see most

or all of the frames at one time. Paired with the note-card or sticky-note storyboards, this feature helps students keep the links organized among sections and web pages. For both software and video products, now is the stage for adding transitions and special effects between frames or segments and additional audio to the final product.

- 6. Test and revise the product**—After their products are complete, students should be encouraged to test them, preferably with the help of others who have not been involved in their development. The aim is to revise the products and meet the criteria outlined in a later section of this chapter, Evaluating Student-Developed Hypermedia and Multimedia Projects.

### Authoring Skills to Develop Over Time

The beauty of hypermedia authoring is that students can create products with skills that range from basic to extraordinarily complex and sophisticated. Teachers have a growing



# Free open source **OPTIONS** for Hypermedia Sites

**TYPES****FREE SOURCES****Commercial products**

The Free Sounds project: <http://www.freesound.org>  
*PBS Kids Interactive Stories*: <http://pbskids.org/lions/stories>  
*Clifford Interactive Storybooks*: <http://teacher.scholastic.com/clifford1>  
*World Almanac for Kids*: <http://www.worldalmanacforkids.com>  
*Nation by Nation Almanac*: <http://www.historycentral.com/nationbynation>

**Interactive presentation hypermedia**

*Ease*: <http://live.gnome.org/Ease/0.1>  
*Google Docs* presentations: <http://www.google.com/google-d-s/presentations>  
*Impress*: <http://www.openoffice.org/product/impress.html>

**Audio/video hypermedia**

*Audacity* audio editing software: <http://audacity.sourceforge.net>  
*GunGirl* audio sequencing software: <http://gungirl-sequencer.en.softonic.com>  
*Avidemux* video editor: <http://avidemux.en.softonic.com>  
*CamStudio* video streaming software: <http://camstudio.org>  
*Microsoft Movie Maker*: <http://www.microsoft.com>  
*Microsoft Photo Story 3*: <http://www.microsoft.com>  
*Open Movie Editor*: <http://www.openmovieeditor.org>  
*VideoPad* video editing software: <http://www.nchsoftware.com/software/video.html>  
*Wax* video editing software: <http://www.debugmode.com/wax>

**Hypermedia production**

*Aha!* hypermedia software: <http://aha.win.tue.nl>  
*Hyperbook* online hypermedia editor: <http://hyperbook.sourceforge.net>  
*CaveWriting* 3-D hypermedia authoring: <http://sourceforge.net/projects/cavewriting>

**Virtual environments**

*Art of Illusion* 3-D modeling software: <http://www.artofillusion.org>  
*Blender* 3-D content creation suite: <http://www.blender.org>  
*JAHSHAKA* visual effects software: <http://www.cinefx.org>

number of online tutorials at their disposal to help students learn the basics of authoring software packages. (See a vast list of tutorials at Lynda.com or the Internet4Classrooms site for links to many of these tutorials.) Students can begin with these tutorials, and teachers can help them move on to advanced techniques in several areas.

**Media literacy.** Given the complexities and proliferation of various media, an understanding of media basics is a fundamental skill for the Information Age. Because most people

have tremendous capabilities to adapt and alter existing media in our present online world, a critically important part of instruction in hypermedia authoring must focus on how to be critical and ethical producers and consumers of media.

**Using music and art.** Visual arts and music play major roles in the effectiveness of hypermedia and multimedia products. As students gain more knowledge in the theory and aesthetics of music and art, they will use these resources more productively in the authoring process, ultimately

enhancing the quality of their hypermedia and multimedia development.

**Print and graphic design principles.** Many principles of desktop publishing also apply to hypermedia designs. When students first see the array of graphics and sound options available, they typically overindulge and use so many colors, graphics, and sounds that content is overshadowed. A selection of design principles that can help guide judicious use of these options is described later in the Evaluating Student-Developed Hypermedia and Multimedia Projects section.

**Video design principles.** For video projects, students learn over time the best ways to illustrate concepts using motion and camera effects. They also learn how to intersperse print and animated titles in their projects.

**Creativity and novel thinking.** One of the strands in the framework of 21st Century Skills is “Creativity and Innovation,” and hypermedia projects are a great place to encourage these skills. Too many student projects resemble glorified paper-based projects, essentially replications of existing materials; they do not take advantage of the true power and affordances (i.e., opportunities for action and interactivity) of this medium. Classroom activities that encourage creative and critical thinking in all subject areas help develop skills and a mindset that naturally enhance the authoring process.

**Considering the audience.** Whenever possible, teachers should try to give students an opportunity to display their projects both locally and to broader audiences made possible by web publishing. Research on writing has shown that students invest more effort in the writing process when they know others will read their writing. Hayes and Desler (2009) and many others have observed that this sense of audience carries over to hypermedia authoring. Fan and Orey (2002) say that, “Because students knew that the final projects would be pressed on a CD, put on the World Wide Web, and presented at conferences, they tended to have a sense of audience. They were no longer writing in a vacuum” (p. 59). However, teachers sometimes find that components of a student project make sense only to the author. Younger students in particular should be reminded constantly that they need to think of their projects from the user’s point of view. Encourage them to test their projects on other students, family members, or friends and to focus on the usability of the project in addition to the embedded content.

## Evaluating Student-Developed Hypermedia and Multimedia Projects

When students create their own multimedia/hypermedia products, Dick and Lindeman (2007) say that such

project-based assignments should reflect seven key aspects. These assignments should: be based on curriculum and grade-level standards, be conducted over an extended time frame, aim to expand student decision making, incorporate collaboration, provide students with a clear understanding of assessment rubrics, have real-world connections, and acknowledge available multimedia resources and skill levels. Basic criteria for assessing student products are summarized in Figure 3. You can use this checklist and other instruments, such as rubrics, to grade student projects as well as to encourage students to self-assess their work and critique the work of their peers.

## MULTIMEDIA AUTHORIZING TYPE 1: PRESENTATION HYPERMEDIA

Presentation software helps users create on-screen descriptions, demonstrations, and summaries of information. A prime example of a design and development technology that migrated from business and industry to the realm of education, this tool was first adopted by business executives and salespeople, who used it to accompany reports at meetings and presentations to clients, helping to make verbal information more visual to listeners. Capabilities for demonstrating, illustrating, and clarifying information became evident, and presentation tools soon began to make their way into K–12 and university classrooms.

Presentation tools began exclusively as **electronic slide shows**, sequences of frames with clip art and text, displayed in a linear way. When it became possible to add complex graphics and video sequences to frames, they evolved into popular multimedia authoring tools. Then, when presentation software began to offer branching and links to external information such as Internet sites, this tool became a hypermedia environment. Today’s presentation software also allows authors to add clickable buttons or “hot spots” to jump to any location in the presentation, giving users control of what they want to see and when they can see it. This expanded the number and type of integration possibilities for students and teachers. Figure 4 shows an example. Notice that buttons labeled “Menu,” “Stop,” “Next,” and “Previous” are all hot spots that send users to various frames in the presentation.

## Resources and Guidelines for Interactive Presentation Hypermedia

The most popular of the presentation software tools is Microsoft *PowerPoint*, but Apple has a similar presentation

**FIGURE 3 Basic Criteria for Assessing Student Hypermedia Products****Content**

- » All information is the most current, up-to-date available.
- » All information is factually accurate.
- » Content is free from typos and misspellings, and from punctuation and grammatical errors.
- » No ethnic, slang, or rude names are used; content is presented in a professional manner.
- » No questionable vocabulary, slang terms, or curse words are used.
- » Content sources (including sources of graphics) are properly referenced.

**Instructional Design**

- » All necessary information is provided in the product to make concepts clear; users are able to understand what is being presented from the information provided.
- » To add interest and motivation for users, information is presented in an innovative and creative way.

**Organization and Navigation**

- » Content is organized and presented in a logical way.
- » Screens are designed for easy navigation; it is clear how to get to and from various parts of the product.
- » To aid navigation and use, the product has a consistent look and feel throughout.
- » Buttons and links all work as indicated.

**Appearance**

- » Use of varying fonts and type sizes is controlled so as not to interfere with readability.
- » Type is large enough to read when projected.
- » Color contrasts with background for easy reading.
- » Bold or plain style is used for main text; no shadow and outline if text is more than a few words long.
- » Fancy fonts and type styles are readable.
- » In frame-based products: Only brief main ideas are listed in a single frame, rather than paragraphs of text.

**Graphics, Videos, and Sound**

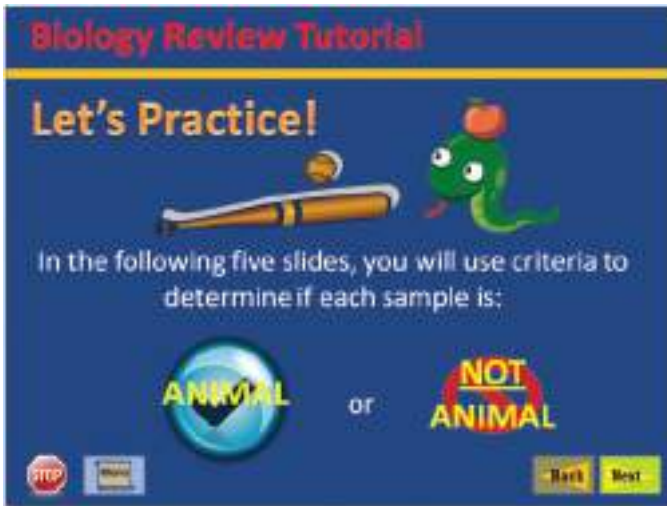
- » Graphics, videos, and sound are included as appropriate to help communicate information on the topic; they are not included just for show.
- » Audio is audible and understandable.
- » Video content is clear and visible.
- » No obscene or rude graphics or visuals are included.
- » Use of graphics (e.g., on-screen animations) is controlled and does not distract from reading.
- » Pictures and sounds associated with buttons and links are appropriate to the purpose and content of the frames.

software called *Keynote* that is available as part of the *iWork* suite.

For large classes and other groups, presentation software products typically are used in conjunction with computer projection systems, which may include large, high-definition monitor panels, digital projectors and wall-mounted screens, or systems that operate as stand-alone devices. All of these devices enlarge the image produced by the software by projecting it from a computer screen onto a wall

screen. However, some integration strategies with interactive presentation hypermedia call for products to be used by individuals working at their own computers. Many of the criteria that are appropriate for projected presentations are not required for individual ones. See Table 4 for a comparison of group and individual design guidelines.

The effectiveness of presentation hypermedia depends largely on the designer's authoring skills described earlier. The most common error in presentation hypermedia is

**FIGURE 4** Sample Interactive Presentation with Linking Buttons

when links fail to work as intended. Two design steps can prevent this. First, in storyboards to lay out frames, make notes on each interactive button to show where users go to when they click it. Second, try out the finished product and/or have others try it out, and go through it using various interactive paths. Make sure all buttons work and send users to the locations the buttons indicate.

## Integration Strategies for Interactive Presentation Hypermedia

Because it is readily available and relatively easy to use, presentation software is often the hypermedia authoring tool of choice for classroom integration and use. A variety

**FIGURE 5** Sample Jeopardy Game

of integration strategies have emerged for these versatile tools.

- » **Game-based reviews**—Interactive presentations based on popular games like Jeopardy have become increasingly popular ways to review skills or content. (See Figure 5 for an example game.) The buttons inserted on the screens send users to various items and can also send them to frames with answers and feedback. The Super Teacher Tools site (<http://www.superteachertools.com>) has a large and useful collection of games in a Jeopardy format that review content for a variety of content topics ranging from mathematics to history.
- » **Interactive storybooks**—With this strategy, students document existing stories or write their own so they

**TABLE 4** Comparison of Design Criteria for Projected and Individual Hypermedia Presentations

Criteria for Presentations Projected to Groups	Criteria for Presentations Used by Individuals
<b>Use large type</b> —So it can be seen from the back of the room (usually 32-point or more)	<b>Type may be smaller</b> —For viewing on an individual's computer
<b>Minimize text on each frame</b> —Use text mainly to focus attention on main points	<b>More text on each frame is okay</b> —If product is for tutoring, more text may be needed
<b>Avoid using fancy fonts</b> —These may be unreadable	Same criterion
<b>Avoid using gratuitous graphics, clip art, and sounds</b> —These interfere with understanding when used only for decoration	Same criterion
<b>Use graphics, not just text</b> —These help convey messages	Same criterion

can be read interactively by others. Those reading these hypermedia stories can click on various places on the screen to hear or view parts of a story. This format also lets students go beyond one basic sequence and create their own branches and endings to stories. Candreva (2010) described this strategy as a way to reinforce and enhance children's literacy skills. Thesen and Kira-Soteriou (2011) used a free software called *Photo Story 3* (listed in the Open-Source Options feature) to allow students to create their own digital stories. They, too, felt it was a powerful way to enrich young students' literacy skills. Technology Integration Example 1 illustrates the use of these "talking storybooks."

- » **Full tutorials**—Teachers can create content sequences to explain and illustrate concepts (e.g., how to solve a math problem) or "how-to" procedures (e.g., a lab procedure) so that students can review these on their own

to prepare for a classroom activity like a lab, or to help study for tests. Tutorials usually have practice items that follow the explanation, which makes interactive buttons especially useful. The program can then branch to different feedback depending on the answer the user selects.

- » **Student-created presentations**—The most powerful strategy for integrating presentation hypermedia is for students to create individual or small-group presentations to document and display the results of research they have done and/or to practice making persuasive presentations. O'Hara and Pritchard (2008) found that students who created interactive *PowerPoint* products to illustrate new vocabulary words were more active and engaged than other students and demonstrated greater understanding of words and concepts they studied. Having learners become the designers and experts of content, in the end presenting their work to the class, can serve as a powerful technology integration lesson for any domain of learning—from art history to math to science to social studies and beyond. *PowerPoint*-type presentations have become so popular for classroom projects that many assessment rubrics for them are now available online (see especially Kathy Schrock's listing of rubrics at <http://school.discoveryeducation.com/schrockguide>).

## TECHNOLOGY INTEGRATION EXAMPLE 1

### SAMPLE HYPERMEDIA PRESENTATION ACTIVITY

**TITLE:** Talking Books Enhance Literacy for Kids with Special Needs

**CONTENT AREA/TOPIC:** Language arts, literacy

**GRADE LEVELS:** Elementary students with physical disabilities

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration

**21ST CENTURY SKILLS:** Core subjects: English; Information, Media, and Technology Skills—Access and evaluate information

**DESCRIPTION:** When students cannot read independently because of their physical difficulties, their reading development is often delayed. They may not be able to turn pages of a book or turn back to re-read a page they enjoy, so they always have to ask someone else to do these things for them. The result is less reading and poorer overall literacy. By making popular children's books into electronic format with *PowerPoint*, students can access these books using a variety of computer access aids. They turn "pages" by activating a switch with whatever part of their body has the best voluntary control.

**Source:** Based on a concept from "Creating Talking Books in PowerPoint" at <http://atto.buffalo.edu/registered/Tutorials/talkingBooks/powerpoint.php>

## MULTIMEDIA AUTHORIZING TYPE 2: AUDIO AND VIDEO PRODUCTION AND EDITING SYSTEMS

Once the exclusive domain of Hollywood, video production is now a growing presence in school activities. Video editing software is to motion images what word processing is to text. There has been an explosion in video editing and production to rival the rapid increase in word processing of documents. Video production can be very time-consuming for anyone who wants to create high-quality videos, and especially so for novice users of video editing software. However, schools across the country are beginning to use these systems to produce school news programs and to develop digitized video for use in the design and development of various hypermedia products.

A new kind of audio and video production emerged with the convergence of three technologies. First, digital cameras and mobile devices, such as cell phones, allowed people to record and/or film events at will. Then the iPod went on the market in 2001 and quickly became a popular multimedia storage device and player. Finally, YouTube

(<http://www.youtube.com>) was activated in 2005, resulting in an explosion of videos posted to share with the world. **Podcast**, a term that combines “iPod” and “broadcast,” coined by British journalist Ben Hammersley in 2004 (Berry, 2006), originally meant posting audio on a website. Now podcasts can also mean posting video on a site such as YouTube, a practice also sometimes referred to as a **vodcast**, or simply **video sharing**. Video and audio files can also be downloaded from services such as Apple’s *iTunes*. Young people were among the first to make audio and video sharing popular, but it has evolved into a new form of multimedia publishing used around the world by people of all ages.

Riddle (2010) notes that the original focus of audio podcasts was to deliver content. For example, college instructors recorded lectures and posted them to the university website or to a distance-learning site so their students could download them, and also used them to create field notes, study guides, and flashcards for students’ use. When audio podcasts and video sharing entered K–12 schools, another focus was added: student-produced media for instruction. Riddle cites the Willowdale Elementary School in Omaha, Nebraska, which uses student-produced podcasts to enhance instruction in topics ranging from art history to tips for helping their fellow students improve their writing skills. She also tells of a teacher in Germany who enhances both his students’ music skills and their English usage skills by combining their music podcasts with the ability to post and receive comments in English about their posts.

## Resources and Guidelines for Audio and Video Production

Audio-video files can be imported onto a computer from a source, such as a phone, digital camera, or webcam, in one of several formats (e.g., **Audio Video Interleave (AVI) format**, **Moving Picture Experts Group (MPEG) format**, **QuickTime® movie (MOV) format**). Once digital video is stored on a computer, the resulting digitized video clips can be inserted into a multimedia package or uploaded to the Internet. Video clips stored in this way are often viewed with free player software, such as Apple’s *QuickTime* or *Windows Media Player*. **Video editing software** allows these movies to be edited and combined with special effects, such as titles, screen fades, transitions, and voice-over audio/sound effects.

If teachers need only audio, for example, to post a musical selection or a lecture, software is available to allow audio recording and editing. Several audio and video production and editing packages are listed in Table 5, along with sample integration strategies.

An example screen from an open-source video editing software is shown in Figure 6. The top of the screen offers video editing options, and the bottom part allows users to manipulate the audio track. By sliding markers on these tracks and dragging the video clips to their intended destinations in the file, students can cut, copy, and/or paste sections of a video and/or combine them with special effects such as fades or background music. The end result can then be uploaded to an Internet website or output and shared on digital media.

**TABLE 5** Sample Audio and Video Production and Editing Software and Instructional Uses

Sample Audio and Video Editors	Instructional Uses
<ul style="list-style-type: none"> <li>• Apple <i>Garageband</i> <a href="http://www.apple.com/ilife/garageband">http://www.apple.com/ilife/garageband</a></li> <li>• <i>Propaganda</i> <a href="http://www.makepropaganda.com">http://www.makepropaganda.com</a></li> <li>• <i>Avid Studio and Pinnacle Studio HD</i> <a href="http://www.pinnaclesys.com">http://www.pinnaclesys.com</a></li> <li>• Adobe <i>Premier Pro</i> <a href="http://www.adobe.com">http://www.adobe.com</a></li> <li>• <i>iMovie</i> <a href="http://www.apple.com">http://www.apple.com</a></li> <li>• Corel <i>VideoStudio Pro</i> <a href="http://www.corel.com">http://www.corel.com</a></li> <li>• <i>PowerDirector</i> <a href="http://www.cyberlink.com">http://www.cyberlink.com</a></li> <li>• <i>Vegas Pro 10</i> <a href="http://www.sonycreativesoftware.com">http://www.sonycreativesoftware.com</a></li> <li>• <i>Final Cut Studio</i> <a href="http://www.apple.com">http://www.apple.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrations of procedures (e.g., science protocols)</li> <li>• Student-created presentations</li> <li>• Video lectures</li> <li>• Video portfolios</li> <li>• Video decision-making and problem-solving simulations</li> <li>• Documenting school activities (e.g., yearbooks)</li> <li>• Teaching video production techniques</li> </ul>

## FIGURE 6 Sample Video Editor



Source: *Open Movie Editor*, <http://www.openmovieeditor.org>. Reprinted by permission.

## Integration Strategies for Audio and Video Production and Editing Systems

Students and teachers are using computer-based video production and editing systems for a variety of purposes, ranging from presenting the daily school news to teaching professional-grade video production skills. Some of these strategies are described here.

- » **Demonstrations of frequently performed procedures**—For activities that are frequently repeated (for example, procedures for science experiments), teachers can film themselves or others completing the steps. These short clips, which provide demonstrations that can be viewed and repeated as many times as desired by students, are useful across curriculum areas. For example, Shumack and Reilly (2011) discuss how to create and use videos of physical education skills and techniques as demonstrations. Brown (2010) observes that using video demonstrations that can be repeated on demand is a good strategy for students with cognitive disabilities, and video modeling is an acknowledged technique to teach children with autism (LeBlanc, 2010). Ehrmann (2011) points out that sharing of video demonstrations among teachers is a good means of saving both money and time.
- » **Student-created presentations**—Although students can produce a video as a way of documenting research findings (as they do with *PowerPoint* and *Keynote* presentations), they often create videos that illustrate

real-life examples of concepts they have learned (e.g., showing how algebra applies to everyday situations) or make documentaries of events and conditions around them (Hofer & Swan, 2008-2009). Bedrossian (2010) described a project that made important scientific and technological discoveries come alive for students as they interviewed, recorded, and made podcasts of oral histories of people who lived during the time these innovations happened. Prensky (2010b) predicts that the ready availability of YouTube for sharing student-created presentations makes this an increasingly powerful instructional technique.

- » **Audio or video aids for classroom discussions**—Teachers can use either audio or video examples as a way to spark discussion or to help students analyze their own behaviors. For example, Pannell and Hutchison (2010) recorded students explaining how they solved math problems involving fractions. The teacher played each recording as she illustrated the problem solution on the whiteboard. Students then discussed which methods were better and compared them to the ones they had been using. Webcams that provide images of local or distant phenomena can also be helpful resources. Technology Integration Example 2 illustrates one of these uses.
- » **Video lectures**—Teachers can capture video of themselves or other experts explaining key concepts (e.g., a video interview with a local community expert for a unit on environmental awareness). These videos can support and extend in-class discussions; they also come in handy if students miss the original presentation or want to review material in a visual way. Note: Make sure speakers are aware you will be recording them, and get their permission to reuse the video for future classes.



Students can create videos that illustrate real-life examples of concepts they have learned or make documentaries of events and conditions around them.

Photo by W. Wiencke.

## TECHNOLOGY INTEGRATION EXAMPLE 2

### SAMPLE VIDEO HYPERMEDIA ACTIVITY

**TITLE:** Webcams Bring Weather to Life

**CONTENT AREA/TOPIC:** Science, physical sciences

**GRADE LEVELS:** High school

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Science; Information, Media, and Technology Skills—Access and evaluate information, use and manage information; ICT—Apply technology effectively

**DESCRIPTION:** Teachers who want a vivid and engaging way to teach physical science and weather concepts can create classroom activities around webcam images of various locations. For example, a flood cam is designed to provide readings of a river's height, along with safety advice and weather predictions. Teachers can use weather webcams in distant locations to illustrate weather concepts. As local weather events occur, they can take advantage of "teachable moments" to show how physical science concepts apply to real-world events.

**Source:** Based on a concept from *A Study in Natural Disasters* at the Education World site: [http://www.educationworld.com/a\\_tech/tech/tech100.shtml](http://www.educationworld.com/a_tech/tech/tech100.shtml)

- » **Video portfolios**—Student portfolios have become more common for assessment purposes, and video systems have assumed a central role in portfolio development. Additionally, many teachers develop portfolios to document their teaching methods in preparation for a promotion or additional certification (Delacruz & Bales, 2010; Randall, 2009).
- » **Video decision-making/problem-solving simulations**—This strategy was made popular with the *Adventures of Jasper Woodbury* videodiscs in the mid-1990s. More recently it was used with an online environment developed by the University of Minnesota for teaching geography called *GeoThentic: Learning Geography through Geospatial Technologies* (see <http://lt.umn.edu/geothentic>). Videos are used to depict problem scenarios that require math, science, or geography skills, and students can review information in the videos as they create solutions to the problems.
- » **Documentation of school activities**—Many middle and secondary schools use video cameras and video

editing software to produce a daily news show or morning announcements. These productions “star” the students themselves, and students control the camera and perform the necessary editing work. News shows offer valuable opportunities to help students develop their research and interviewing skills, on-camera presentation skills, and technical production skills. When schools create video yearbooks, students capture video clips of events and merge them into a collage of the year’s events.

- » **Visual literacy instruction**—Now that video and, more recently, online video, has established itself as playing a significant role in our society, visual literacy is a requirement for academic success, as well as success in many careers. Through analyzing information in video format, students learn how people can use visual images to communicate biases and make persuasive arguments in advertisements and news stories. This enables students to become more thoughtful (and sometimes more cautious) consumers of digital information and marketing. Sandell (2011) describes several strategies for helping today’s **screenagers** (Rushkoff, 2006), that is, those young people who are “living visually and virtually from handheld screens, smart phones, and computers...[and who] increasingly need multiple forms of literacy, especially visual literacy, which is to images what reading and writing are to words” (p. 48).
- » **Teaching video production**—Technology education labs typically feature video production as one of the required learning stations. Students in these labs usually create the school’s news shows and morning announcements (Loveland & Harrison, 2006). Pinkstone (2010) says that, “Filmmaking crosses several curriculum areas (English, visual arts, drama, and media studies) and is an excellent way to engage students in their learning and develop their practical skills” (p. 12). She also tells of film-making competitions that invite student-produced works, thus providing even greater motivation to acquire skills in these important areas. Online sites such as SchoolTube (<http://www.schooltube.com>) and TeacherTube (<http://www1.teachertube.com>), which are especially designed for hosting student video projects, provide a rich, yet safe environment for using and posting these kinds of projects.

## MULTIMEDIA AUTHORING TYPE 3: HYPERMEDIA PRODUCTION SOFTWARE

In the late 1980s, early hypermedia authoring programs included *HyperCard* for Macintosh, *LinkWay* for MS-DOS



machines, and *TutorTech* for Apple II computers. These programs represented a major leap forward in technology, but because designers had to invest major time commitments to learn and use the software, their use was limited. Things began to change when Roger Wagner's *HyperStudio* was released in 1988. This program used the same basic "card and stack" metaphor as *HyperCard* did, but it eliminated much of the need for extensive scripting or for programming commands.

## Resources and Guidelines for Hypermedia Production

Two types of resources are currently available to develop hypermedia environments. The first results in programs that run on computers but have links to web resources; the other is for designing environments that are completely web-based. Example packages of both types are shown in Table 6.

After a period in the early 2000s when *HyperStudio* was not actively supported, it was again offered for sale and came back into use in schools. It is still being used as a platform for student-produced hypermedia and now has additional multimedia features, including the ability to podcast and connect with YouTube and other social media sites. (See some of the *HyperStudio* tools in Figure 7.)

In recent years, many programs have become available that make it possible to create online hypermedia, including web creation programs like Adobe *Creative Suite* and Microsoft *Expressions Studio*. One of the programs included in Adobe's *Creative Suite* is Adobe *Flash*, which has become the industry standard for creating interactive web-based animations and other web-based motion features. Adobe *Flash* merges a powerful yet easy-to-use visual environment with a robust programming language (ActionScript), thereby allowing developers to combine aesthetically pleasing interfaces

**FIGURE 7** Sample *HyperStudio 5* Screen



Source: Reprinted by permission of the Software McKiev Company.

with powerful programming techniques. Adobe *Flash* files are also very small and download quickly over the Internet. *Flash* has a built-in Script Assist wizard to help beginners learn basic programming skills.

## Integration Strategies for Hypermedia Authoring Software

Multimedia and hypermedia development projects are taking the place of many traditional activities to accomplish the same purposes. Some common classroom applications of multimedia and hypermedia are described here and summarized in Table 6.

**TABLE 6** Sample Hypermedia Development Software and Instructional Uses

Sample Hypermedia Development Software	Instructional Uses
<ul style="list-style-type: none"> <li>• <i>HyperStudio 5</i> <a href="http://www.mackiev.com/hyperstudio">http://www.mackiev.com/hyperstudio</a></li> <li>• <i>MediaWorks</i> <a href="http://www.mediaworkssoftware.com">http://www.mediaworkssoftware.com</a></li> <li>• Microsoft <i>Expressions Studio</i> <a href="http://www.microsoft.com/expression/products/StudioWebPro_Overview.aspx">http://www.microsoft.com/expression/products/StudioWebPro_Overview.aspx</a></li> <li>• Adobe <i>Creative Suite</i> <a href="http://www.adobe.com/products/creativesuite/web.html">http://www.adobe.com/products/creativesuite/web.html</a></li> <li>• <i>Web Studio 5.0</i> <a href="http://www.webstudio.com">http://www.webstudio.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrations of frequently performed procedures</li> <li>• Student-created presentations</li> <li>• Audio or video aids for classroom discussions</li> <li>• Video portfolios</li> <li>• Video decision-making and problem-solving simulations</li> <li>• Documentation of school activities</li> <li>• Visual literacy instruction</li> <li>• Teaching video production</li> </ul>

- » **Brief tutorials**—Both teachers and students can create hypermedia instructional sequences that step the user through the components of a topic. For example, Twombly, Holtz, and Tessman (2008) describe a series of animated tutorials, accompanied by games and quizzes, that guide high school students through concepts about drug abuse.
- » **Student-created presentations**—As with other types of hypermedia, student-created products are among the most powerful constructivist strategies. For example, Hernandez-Ramos and La Paz (2010) found that when students created hypermedia mini-documentaries in history topics, they were more engaged and achieved deeper understanding of history than did students using more traditional methods.
- » **Interactive storybooks**—This is the same strategy described earlier under presentation hypermedia and is often seen as a way to reinforce and enhance children's literacy skills. Hypermedia software such as *HyperStudio* can be used for this kind of activity, as well as presentation software such as *PowerPoint*.
- » **Student-designed hypermedia environments and games**—Having students design websites and other hypermedia products is a challenging and complex problem-solving process. It encourages reflective and critical thinking in which students not only experience and work with new media in an authentic setting but also have the opportunity to explore new forms of expression by designing elements that best organize and communicate their desired content or goal. Placing students in the role of designer/developer is a path to achieving several 21st Century Skills, such as problem solving and creative thinking. Lee (2011) describes the benefits for gifted students of creating their own animations and games. See Technology Integration Example 3 for an illustrative curriculum lesson with *HyperStudio*.

## TECHNOLOGY INTEGRATION EXAMPLE 3

### SAMPLE HYPERMEDIA DEVELOPMENT ACTIVITY

**TITLE:** Immigrant Experiences

**CONTENT AREA/TOPIC:** Social studies, history

**GRADE LEVELS:** Middle school

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Social studies; Communication and Collaboration—Collaborate with others; Information, Media, and Technology Skills—Access and evaluate information; Social and Cross-Cultural Skills—Work effectively in diverse teams

**DESCRIPTION:** Students use *HyperStudio* to create a multimedia presentation comparing the experiences of immigrants who arrived at New York's Ellis Island with the experiences of those who arrived at California's Angel Island. Assign students to work in small groups, with half the class researching Ellis Island, and the other half Angel Island. As they research, they should look for information and photographs relating to the ethnic, social, economic, and cultural background of the immigrants; their reasons for immigrating; and their experiences while traveling to, arriving at, and living in the United States. They present their findings to the entire class.

**Source:** Based on concepts from *Immigrant Arrivals* at the Education World website: [http://www.educationworld.com/a\\_lesson/00-2/1p2165.shtml](http://www.educationworld.com/a_lesson/00-2/1p2165.shtml)

## MULTIMEDIA AUTHORIZING TYPE 4: VIRTUAL ENVIRONMENTS

Once only dreamed of in science fiction, some types of **virtual reality (VR)** or 3-D environments are now seen frequently in classrooms. Through various visual and tactile devices, VR can represent real or imaginary worlds in which the user interacts through multiple senses: a true multimedia environment. Although the first VR systems, created for the military and the aerospace industry, required sophisticated computers with advanced computer graphics, other types of VR have been developed that require less sophisticated capabilities and less expensive technology.

## Resources and Guidelines for Virtual Environments

The potential of VR systems to make cyberspace seem real has been talked about since William Gibson's 1984 novel, *Neuromancer*, in which people used **avatars**, or graphic icons, to represent themselves in virtual environments. Until recently, however, that potential has been tapped more for video games than for education. Four types of VR are described here, three of which are commonly used in K–12 classrooms; educational use of the fourth type is usually limited to university research settings.

- » **Full immersion systems**—Though not often used in education, this is what people typically envision when they think of VR. In **full immersion systems**, the user places a headset (e.g., goggles or a helmet) over the eyes. Known as a **head-mounted display (HMD)**, this headset is the channel through which the wearer “sees” the computer-generated environment. Other configurations use a large curved projection screen to immerse the user in the environment. In both VR systems, views of the “real” world are replaced with views of the virtual one, and the senses create an illusion of actually being in the environment the system displays. Other devices for full immersion systems include sound and tactile or **haptic interfaces**. Sound usually is presented to the user through stereo headphones that may or may not be built into the HMD. The user wears a glove or brace-like device that provides tactile feedback when the user “grasps” an object in the virtual world.
- » **Web-based VR**—This type of VR is made possible by **Virtual Reality Modeling Language (VRML)**, **EXtensible Markup Language (XML)**, and **Voice EXtensible Markup Language (VXML)**. Just as Hypertext Markup Language (HTML) describes what a web page will look like in a browser, VRML and XML are programming languages that describe the geometry and behavior of a computer-generated scene or virtual world. VXML helps create environments where a user interacts with the Internet through voice-recognition technology. Although not as realistic as full immersion VR, web-based VR costs much less to implement. The technical requirements for creating VRML products limited their use in education until 2003, when Linden Labs released the online VR environment *Second Life*, an online virtual world created entirely by its users. In such “worlds,” users create an avatar to represent their digital presence; then they explore the digital world to connect and collaborate with others, build houses and communities, and even sell items in the environment in exchange for real money. K–12 educators had high hopes for *Second Life*. Coffman and Klinger (2007) suggested that immersing students in virtual environments such as *Second Life* could be meaningful and engaging. K–12 uses have been reported (High schoolers attend college in ‘Second Life,’ 2011; Lu, 2010). However, because *Second Life* is considered primarily an adult learning environment, its use in education is usually in post-secondary courses. Similar virtual environments have been designed especially for children and teenagers, and these are seeing more use in schools. For example, Kozdras (2009) reported that immersion in *Webkinz* and similar “worlds” can help teach children “financial literacy” concepts. Merchant (2010) sees these environments as ways to teach students important digital literacies and believes they can re-define how we view the concept of “being literate.” See sample virtual environments in Table 7 below and this chapter’s Hot Topic for Debate.
- » **3-D models**—These are made possible with sophisticated software that creates three-dimensional replicas of objects or locations. The products are then viewed on a flat screen computer (as opposed to an immersive environment). Some 3-D models are transferred to VRML and viewed via web browsers, as described above. **Virtual manipulatives**, or replicas of real manipulatives that are accessed via the Internet (Li & Ma, 2010), are one of the most popular types of 3-D models. The National Center for Virtual Manipulatives (<http://nlvm.usu.edu>) at Utah State University has a large collection of these tools to support math and science topics, along with instructions for teachers on how to use them. Wang, Kenzie, McGuire, and Pan (2010) find that virtual manipulatives support inquiry learning by allowing children to

**TABLE 7** Sample Virtual Environments and Instructional Uses

Sample Virtual Environments Software	Instructional Uses
<ul style="list-style-type: none"> <li>• <i>Second Life</i> <a href="http://www.mackiev.com/hyperstudio">http://www.mackiev.com/hyperstudio</a></li> <li>• <i>Webkinz</i> <a href="http://www.webkinz.com">http://www.webkinz.com</a></li> <li>• <i>Whyville</i> <a href="http://www.whyville.com">http://www.whyville.com</a></li> <li>• <i>Club Penguin</i> <a href="http://www.clubpenguin.com">http://www.clubpenguin.com</a></li> <li>• <i>Neopets</i> <a href="http://www.neopets.com">http://www.neopets.com</a></li> </ul>	<ul style="list-style-type: none"> <li>• Brief tutorials</li> <li>• Student-created presentations</li> <li>• Interactive storybooks</li> <li>• Student-designed hypermedia environments and games</li> </ul>

## DOES VIRTUAL LIFE CHANGE “REAL” LIFE?

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 Sherry Turkel's latest book, *Alone Together: Why We Expect More From Technology and Less From*

*Each Other* (2011), she says that “technology is changing how people relate to one another and construct their own inner lives” and people are making “convenience and control a priority while diminishing the expectations we have of other human beings.” (See <http://www.nytimes.com/2011/02/22/books/22book.html>) Turkel's argument is that the virtual life made possible by our technology tools is changing our “real” lives in fundamental ways. What evidence can you present that we relate to each other differently because of our technology tools? Or do you find evidence that technologies merely make it possible to do more quickly what we would do anyway?

“manipulate representations by flipping, turning, or rotating objects (e.g., geometric shapes), helpful for reinforcing critical mathematics skills, such as numbers and operations, algebra, geometry, and measurement” (p. 385).

- » **QuickTime VR (QTVR)**—Originally made possible through the *QuickTime VR Authoring Studio* from Apple, this type of VR is easy to access using the standard *QuickTime* player available free from Apple. It requires much less effort to create than immersion systems, VRML, or 3-D models. In QTVR, you can take a series of photographs at 360 degrees around a pivotal point. For example, a classroom could be recorded by setting up the camera in the middle of the room on a tripod. A series of 16 photos would be taken at 22.5-degree intervals. The photos are then input into a QTVR authoring software that “stitches” them together into a seamless panoramic view of the room. Because QTVR uses actual photographs to create the panorama, it provides a more realistic representation than computer-generated systems do. QTVR was projected to have good adoption in K–12 classrooms, but though the software is still available, few such uses have been reported in the literature.

## Integration Strategies for Virtual Environments

Though not as commonly used as other forms of hypermedia, VR is generating interest as a tool for many instructional needs. Some common classroom applications of VR resources are described here and summarized in Table 7.

- » **Imaging for virtual field trips**—One VR application is QTVR panoramas created and used for virtual field trips. Stevenson (2001) described a variety of virtual field trips that use QTVR movies to give tours of locations around the world. She also provides information on how to create a virtual field trip.
- » **3-D models to illustrate how systems work**—Although still limited to more technical topics in the areas of mathematics, science, architecture, and engineering, 3-D modeling is experiencing increased use in education as a way to help students visualize mathematics and science concepts. Example models are described to study characteristics of the solar system (Bakas & Mikropoulos, 2003) and processes of photosynthesis (Mikropoulos, Katsikis, & Nikolou, 2003). Bradley and Farland-Smith (2010) say that 3-D models

are an important resource for science, helping teach common high school concepts like “Punnett square, cell membranes, photosynthesis, and microscope usage” (p. 34). Sun, Lin, and Wang (2010) report good results with using a 3-D model to help children learn abstract concepts related to movements of the Earth, sun, and moon.

- » **Immersive learning environments for practice, exploration, communication, and collaboration**—Full immersion systems are usually limited to university settings, but they have seen use in special education as a way to allow students to practice skills in a

realistic but safe setting. Goldstein (2002) describes one such use with software designed to help students with attention deficit disorders and/or mobility and visual problems. Becker and Schuetz (2003) describe a VRML-based lesson for modeling groundwater flow for geology students. Orman (2003) describes a virtual environment for training performing musicians to prepare for the pressures of live performance, which she feels has great promise for this purpose. Birchfield and Megowan-Romanowicz (2009) report that use of an immersive environment for teaching science concepts increased achievement of high school students.



## SUMMARY

(left to right) © Shutterstock, Fotolia, iStockphoto, Shutterstock

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

### 1. Basic Hypermedia Concepts

- » Multimedia means “multiple media” or “a combination of media,” and hypermedia means “linked or interactive media.” Hypermedia is the term currently in use for most such systems.
- » Commercial hypermedia products in education include: instructional software, interactive or electronic storybooks, reference materials, and collections of development resources.
- » Impact of hypermedia in education offers: increased motivation, flexible learning modes, development of creative and critical thinking skills, and improved writing and process skills.
- » Research on the impact of hypermedia has been done to offer guidelines for achieving maximum benefits and impact on motivation.
- » Recent developments in hypermedia systems include convergence of offline (disc) and online (Internet) development and increased ease of use.

### 2. Hypermedia Design and Development Procedures

- » Hypermedia authoring resources include audio, video, photographs, graphic images, and text.
- » Hardware requirements include a computer with keyboard, mouse, and monitor, digital cameras, scanners, video digitizers, camcorders and other video input, microphones, and audio speakers. Software requirements depend on the type of environment and can include a VRML programming language, 3-D software, or simply the use of a site such as *Webkinz* or *Second Life*.

- » Hypermedia design and development procedures include: (1) Review existing products, (2) Perform research first, (3) Storyboard, (4) Develop individual frames and segments, (5) Add links and/or scripts, and (6) Test and revise the product.
- » Authoring skills to develop over time include: media literacy, using music and art, print and graphic design principles, video design principles, creativity and novel thinking, and considering the audience.
- » Evaluating commercial and student-developed hypermedia products requires use of an instrument such as a rubric (example given in this chapter).

### 3. Hypermedia Authoring Type 1: Interactive Presentation Hypermedia

- » Presentation hypermedia environments are made possible by the interactive qualities of presentation software such as *PowerPoint*.
- » Integration strategies include: game-based reviews, full tutorials, and student-created presentations.

### 4. Hypermedia Authoring Type 2: Audio and Video Production and Editing

- » These environments require video and audio editing software.
- » Integration strategies include: demonstrations of frequently performed procedures, student-created presentations, audio or video aids for classroom discussions, video portfolios, video decision-making/problem-solving simulations, documentation of school activities, visual literacy instruction, and teaching video production.

**5. Hypermedia Authoring Type 3: Hypermedia Production Software**

- » These environments require the use of an authoring program, such as *HyperStudio*, or website-creation programs, such as the Adobe *Creative Suite* or Microsoft *Expressions Studio*.
- » Integration strategies include: brief tutorials, student-created presentations, interactive storybooks, and student-designed hypermedia environments and games.

**6. Hypermedia Authoring Tools Type 4: Virtual Environments**

- » Four types of environments are considered virtual: full immersion systems, web-based VR, 3-D models, and *QuickTime VR*.
- » Integration strategies include: imaging for virtual field trips, 3-D models to illustrate how systems work, and immersive learning environments for practice, exploration, communication, and collaboration.



# 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.** Despite decades of research evidence to the contrary, a popular belief persists among teachers and students that students learn better when they are allowed to use their preferred learning styles. (Search for and locate the 2008 Mayer article mentioned in this chapter, and find the 2008 article by Pashler, McDaniel, Rohrer, and Bjork at [http://www.psychologicalscience.org/journals/pspi/PSPI\\_9\\_3.pdf](http://www.psychologicalscience.org/journals/pspi/PSPI_9_3.pdf).) Hypermedia environments are felt to be a way of allowing students to have their choice of learning formats. Why do you think this belief in the usefulness of hypermedia to support learning styles persists in the face of compiled evidence?

**2.** A popular hypothesis in research on video game environments is that cognitive skills learned in these environments will transfer to other, non-game environments. Mayer (2008) says that evidence gathered to date does not confirm that transfer will occur automatically. What research evidence to date can you find to support or refute this hypothesis or to suggest ways of making skills transfer more readily?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add the:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
    - » Wikis
    - » Blogs
    - » Social networking sites
    - » Internet searching
    - » Distance education
    - » Videoconferencing
    - » Internet research
    - » Internet navigation
  - b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
  - c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.
- a. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
    - » What is the relative advantage of using the technology(ies) in this lesson?
    - » Reflect on, assess, and describe your Tech-PACK for this situation.
  - b. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
    - » What are the objectives of the lesson plan?
    - » How will you assess your students' accomplishment of the objectives?
    - » What integration strategies are used in this lesson plan?
    - » How would you prepare the learning environment?
  - c. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
  - d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
  - e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on the Tech-PACK situation and analyze it by answering the questions.

*Ms. Chou is a high school English teacher who has taught since she graduated from a university about 10 years ago with a major in English and a minor in secondary education. She has always been concerned about the poor quality of writing she sees in her students' papers, but she finds it very difficult to get most of them to improve. They seem uninterested in writing, and she is always challenged to motivate them. Lately, she has been reading about expanded definitions of literacy that include digital literacy and thinks that perhaps her young "digital natives" (as Prensky, 2010a referred to them) would enjoy writing more if they were communicating in a "digital language." She would like to have her students do audio or video interviews of local people who write for a living (e.g., journalists, authors, technical writers) and then create an online hypermedia environment that describes their findings. This would also serve to help them see how important writing is for many professional people. She has almost no experience with doing video or creating hypermedia, but a colleague has volunteered to help her with this project by showing her how to create video and websites.*

- a. Deconstruct Ms. Chou's Tech-PACK in the following way. Fill in the following matrix to show what she knows and what

she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

## 5. WHAT'S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the "What must be learned" column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.

## MyEducationLab™

- » 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

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:

- » 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.



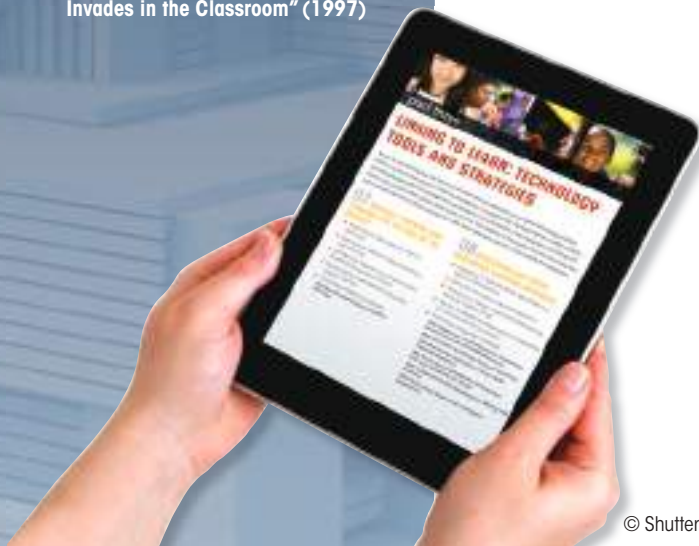
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# **DISTANCE TEACHING AND LEARNING AND THE ROLE OF THE INTERNET**

# DISTANCE TEACHING AND LEARNING AND THE ROLE OF THE INTERNET

The Internet has the opportunity to make education much more intimate and personalized. It is ironic because the Internet is much more broad-scaled than any other mediums, yet it has the potential to be much more individualized.

Tim Armour, Executive Founder of the Jason Foundation, in "The Net Invades in the Classroom" (1997)



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## o u t c o m e s

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

1. Examine the evolution of distance education from historic and current perspectives
2. Create and communicate a rationale for using the Internet to promote teaching and learning.
3. Demonstrate how to navigate the Internet so that it is safe for students and teachers and identify material that is appropriate for classroom use.
4. Devise instructional activities that focus on searching and storing files on the Internet.
5. Create instructions that facilitate students' understanding of ways to communicate using the Internet.
6. Develop instructional activities using social networking and collaborative tools.
7. Analyze the characteristics and tools used to create successful online courses.
8. Research sources of relevant apps and articulate how they can be used to enhance teaching and learning.

## key terms

app  
ARPAnet  
asynchronous  
avatar  
avatar spaces  
blended (hybrid) learning  
blog

Bookmarks file  
bulletin board (BB)  
chatrooms  
cloud computing  
cookies  
course management  
system (CMS)

cyberbullying  
distance education (DE)  
domain designator  
download  
e-Portfolios  
Favorites file  
filtering software



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# TECHNOLOGY INTEGRATION IN ACTION: A RESEARCH PAPER

GRADE LEVEL: High school • CONTENT AREA/TOPIC: Research, study skills • LENGTH OF TIME: Nine weeks

## PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

### Step 1: Determine relative advantage.

Ms. Almon was the library media specialist at Werebest High School. One of her tasks was to help all teachers and students use the library's resources effectively for students' research paper assignments. Over the years, she had compiled a substantial collection of handouts, lists of sources, and assessment materials, which she copied, placed in notebooks, and updated periodically. However, she and the teachers agreed it was difficult to get students to use these notebooks. The students' study skills and organizational strategies left a lot to be desired, and each teacher seemed to have a different approach to teaching these important skills. As she and the teachers talked about this situation, they agreed that it would be better to have these materials available on a website, so that students could access them wherever they were, the materials could be easily updated, and the approach for doing research would be consistent across all classes. They decided to work together to create a research paper resource website. They also decided they would

use this site and a set of video tutorials to structure a series of teaching activities to help students complete research paper assignments.

### Step 2: Assess Tech-PACK.

Ms. Almon knew that before she moved forward with this project she should assess her knowledge and what would be required to have the website developed at the optimal quality.

**Content Domain.** First, she evaluated her content knowledge and realized she definitely knew enough to guide such a project, as she had been a media specialist for over 20 years.

**Technology Domain.** The area that stressed Ms. Almon the most was her technology skills. She had no idea how to design a website or simply even where to start with such a project. However, two of the teachers she was working with knew how to use *Google Sites* and *Apple iWeb* very well, and they all knew that if they collaborated and taught each other, they could easily create a website for the research papers.

**Pedagogy Domain.** Furthermore, another teacher who was collaborating with Ms. Almon had used numerous videos in his classroom to teach social studies, so they felt that as a team they would be successful.

firewall software  
hackers  
hash tag  
hits  
hybrid learning  
hypertext  
instant messaging (IM)

Internet  
learning community  
link/hot link  
listserv (list)  
*Mosaic*  
netiquette  
open-source software

podcast  
Quick Response (QR) codes  
search engines  
social networking site (SNS)  
synchronous  
telecourses  
text messaging

tweet  
uniform resource locator (URL)  
universal apps  
videoconferencing  
web browser  
wiki  
World Wide Web (WWW)



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## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Ms. Almon and the teachers decided they would structure their assessments around the “Big6” information literacy skills as well as around the quality of content in the students’ research papers. To make sure that all teachers structured students’ learning in the same way, they agreed on objectives for each of these skill areas and created assessment methods to measure each of them. They also decided to measure student attitudes toward research and writing. The outcomes, objectives, and assessments they decided on were as follows:

- » **Big6 information skills 1-3. Outcome:** Defining, searching for, and acquiring information. **Objective:** Students will identify a topic for a research paper, use the project website to identify published sources of information related to the topic, and locate the items of information. **Assessment:** Checklist of required tasks and products from information searches.
- » **Big6 information skills 4-6. Outcome:** Analyze, synthesize, and evaluate information. **Objective:** Students will write summary analyses of the information in each item they locate, write a synthesis across all information, and prepare an outline of the points they will emphasize in their research

papers. **Assessment:** Checklist of required tasks and products from information analyses.

- » **Final paper. Outcome:** Write a research paper. **Objective:** Students will achieve a rubric score of at least 15 of 20 possible points on an assigned research paper. **Assessment:** Rubric on research paper content, structure, mechanics, and creativity.
- » **Attitudes toward writing and research. Outcome:** Positive attitude toward research and writing. **Objective:** The students will demonstrate a good attitude toward the writing approach and research used in the project by reporting a rating of at least 45 of 50 possible points on an attitude survey. **Assessment:** Likert scale attitude survey.

### Step 4: Design integration strategies.

Ms. Almon and the teachers worked together to determine what they would place on the resource website and how students would use it. They decided the site would be most useful if it provided links to other helpful sites and a structure to help students work through the process of doing their searches and writing their papers. They also decided they should create short video tutorials on key points in the process, such as how to select a research paper topic and how to use a graphic organizer to create a visual outline. The website and the tutorials should also help make the teaching process more consistent across classes. They decided to recommend the following time frame for the research paper project:

- » **Week 1: Introducing the project and identifying a topic.** All teachers introduce the research paper project by displaying the website to the whole class, using a large monitor or projection system. They review the steps, discuss the process (displaying some of the links at each step), show the first video tutorial, and help students select their research paper topics.
- » **Weeks 2-3: Helping students obtain information.** The teachers show students how to use website links to search for information related to their topic. One of the activities is deciding which type of resource to use. For resources that can best be found in the library, Ms. Almon arranges to show students how to access these resources in the library media center, using a video tutorial as an overview. Students use

## AN EVOLVING USE OF THE INTERNET: DISTANCE EDUCATION

Most of us cannot remember a time when cell phones and text messaging were not the norm; when we couldn’t “google” something we did not understand; or a time when emailing was not a daily activity. Technology is changing every aspect of society as we know it. The technological norms are no longer the typewriter and the telephone, but

the laptop, tablet, and smart phone. Even in the rapid environment of technological evolution, remarkable changes in communications, in particular, have come about with incredible speed; some resources have developed from possible to pervasive in only a few years. These changes are by no means complete or even slowing down.

The primary reason for this breathtaking revolution in communications is society’s recognition of the importance of ready access to people and resources. If “knowledge is power,” as Francis Bacon said, then communication

the website resources at the classroom workstation or in the computer center, depending on what else the teacher is doing in the classroom during this time.

- » **Weeks 4–6: Helping students analyze and synthesize information.** The teachers help students review their information and make decisions on how to structure their paper and what to include in it. They show videos on graphic organizers and let students practice using these techniques.
- » **Weeks 7–8: Writing the papers.** During this time, students complete most of the writing on their papers at home or in the library media center after school. Some teachers allocate class time for students to work in class and to review and give feedback on students' word-processed drafts.
- » **Week 9: Presentations.** Students present their papers using the strategy selected by their teacher. Some prepare *PowerPoint* presentations to accompany their oral presentations; others create a video or a web page with links to other resources.

### Step 5: Prepare instructional environment.

The main preparation task for the project was creating the website and video tutorials and deciding what to include in each. However, Ms. Almon also had to coordinate the students' trips to the library media center. Preparation tasks included:

- » **Creation of website content:** Ms. Almon and the teachers decided on the sections of content to include. Then each of them searched for the best links to include, made a Bookmark/Favorites file of the sites they found, and wrote the content for that section of the site. Ms. Almon compiled the materials into a website and uploaded the site to the school server.
- » **Video development:** The teachers also decided on four topics that would support the teaching of research paper strategies and could be presented well via video. Ms. Almon worked with the district media department to create the four brief video tutorials—how to select a research paper topic, how to create a graphic organizer, how to use the library media center resources, and strategies for presenting a research paper. These were placed on the school computers and on a DVD, and copies were given to each teacher.

» **Handout:** To make sure students understood the assignment and had access to all resources, Ms. Almon created a handout that all teachers could give their students. She also posted this handout on the website so that students could **download** it (transfer it from the Internet to their computer) whenever they wished.

» **Library media center and computer lab scheduling:** Before students began work on the projects, the teachers scheduled time for their students in the lab and in the library media center.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

After all students had completed their research papers, the teachers met to review the data they had collected. Students did very well on the first set of information skills but less well on the second set. Student attitudes toward the writing process were generally high: About 75% of students rated it 20 points or more. Comments volunteered by students on their surveys indicated they would like more in-class time to revise their products and more individual assistance with the revision process. Rubric scores on research papers were also generally good, with noticeable improvement in the areas of structure and content. Scores were lowest on mechanics.

### Step 7: Make revisions.

The teachers decided to create a set of writing exercises to give students more concentrated practice on analysis and synthesis skills before doing their own written summaries. They also decided to target one or two mechanics skills for special practice with word-processed exercises. All the teachers agreed that the website and video tutorials had been critical focal points in making instruction across classes more consistent and easier to follow.

Based on concepts from "So You Have to Do a Research Project?" from East Greenwich Public Schools

is freedom—freedom for people to reach information they need in order to acquire knowledge that can empower them. This heady freedom permeates the atmosphere of a 21st century Information Society.

When viewed in the context of this revolution in communications, it is not surprising that distance technologies have come to play a central role in teaching and learning. Yet there is so much to learn about distance education that many educators find it difficult to know where to begin.

## A Brief Overview of Distance Teaching and Learning

Being always connected on our smartphones and tablets has led to rapid developments in communication characteristics. We are now at a point in our society where constant communication and connection to the Internet is simply ubiquitous. This ubiquitous use of technology has given new life to education in the form of **distance education (DE)**. The United States Distance Learning Association (USDLA) defines

distance education as “structured learning that takes place without the physical presence of the instructor” (Holden & Westfall, 2010, p. 3).

Distance learning has not only changed how quickly educators and students can exchange and access information; it also has altered the educational equation in fundamental ways. Thanks to distance technologies such as broadcast television systems and the Internet, learning has escaped the physical boundaries of the classroom and the school, and students and teachers have become part of a virtual classroom they share with counterparts around the world. Our society is just beginning to understand and take advantage of the potential of this new classroom. From a time when our daily life was using the Internet sporadically for resources and information, to a time when the Internet is one of the main means of interacting with each other, the times are changing, and it is time for all educators to become part of this worldwide trend and influence.

The Internet burst on the scene in our society and in education a relatively short time ago. In fact, it wasn't until the late 1990s that the phrase Internet became commonplace in society. The Internet quickly set fire to the interest and imagination of even the least technical teachers, students, and parents. Almost all distance learning applications today involve some Internet resource or activity, and many rely exclusively on Internet materials. Distance learning is not just the delivery of whole courses but also refers to the use of the Internet and other resources to play key roles in all kinds of classroom communications. Because the Internet figures so prominently in many distance learning activities, the rest of this chapter focuses primarily on this rapidly growing and evolving force in education.



## Distance Learning Delivery Systems

Although the Internet was the catalyst for an unprecedented interest in distance learning, it is by no means the only delivery system for distance learning. Indeed, distance learning can be done without any electronic assistance at all. Distance learning has been done by correspondence study via postal mail (a.k.a., snail mail) since the 19th century. Changes in our technological capabilities have brought about gradual changes to our methods of delivering instruction at a distance. The first major change to correspondence courses came when presentations were placed on videotape and mailed along with print materials. Later, improvements in the quality and availability of broadcast technologies made it possible to send audio and video information, either live or taped.

Distance delivery systems can be classified in any of several ways. Simonson, Smaldino, Albright, and Zvacek (2000) suggested a classification scheme based on Dale's cone of experience, a system designed by Edgar Dale to categorize media according to their degree of realism. Dale said media range from concrete (e.g., hands-on or multisensory experience) to abstract (verbal symbols such as text descriptions), and that younger or less experienced students require more concrete experiences before they can understand abstract ones. Thus, distance delivery systems can be classified according to the degree to which they approximate reality. However, this classification system also may be overlaid with the methods and technologies used to deliver them.

Sometimes several of the technologies listed in Table 1 are used in combination to achieve the desired level of

**TABLE 1** Classification System for Distance Learning Delivery

	Types of Interaction	Delivery Methods
<p><b>Most abstract, least realistic</b></p> 	<ul style="list-style-type: none"> <li>• One-way, print-based</li> <li>• Tape or broadcast audio mailed or downloaded to students</li> <li>• One-way, synchronous audio from instructor to students</li> <li>• Two-way, synchronous audio between students and instructor</li> <li>• Taped or broadcast video mailed or downloaded to students (no synchronous interaction with instructor)</li> </ul>	<ul style="list-style-type: none"> <li>• Correspondence courses via postal mail and/or fax</li> <li>• Prerecorded audio or video</li> <li>• Broadcast radio</li> <li>• Audioconferencing telephone systems</li> <li>• Broadcast television: microwave or satellite link</li> </ul>
<p><b>Most realistic, least abstract</b></p> 	<ul style="list-style-type: none"> <li>• Text and multimedia interactions</li> <li>• Live video from instructor to students (with synchronous audio interaction)</li> <li>• Two-way synchronous video between instructor and students</li> </ul>	<ul style="list-style-type: none"> <li>• Web-based course management systems</li> <li>• Teleconferencing</li> <li>• Videoconferencing</li> </ul>

realism. Currently, two of the most popular arrangements for distance learning are video courses, or **telecourses**, and web-based courses. Telecourses are still more common in higher education than they are in K–12 levels, but some K–12 curriculum materials are also delivered in this way (e.g., integrated science units broadcast from the University of Alabama to schools). **Videoconferencing** (live video and audio communications) via the Internet unfortunately is still not as frequent today as hoped, but it is increasing. Videoconferencing is being used in many adventure learning programs, such as the Earthducation Adventure Learning Series (<http://www.earthducation.com>), where students can talk with educators and explorers as they travel in remote regions of the world. Other programs have linked students to NASA’s astronauts and scientists, and to the divers who explored the Titanic.

## Types of Distance Learning Activities

Once a rarity in education, distance learning activities have become a mainstream alternative to and supplement for face-to-face learning. As Table 1 indicates, some distance activities are carried out via broadcast and stored video and audio (e.g., videoconferencing and podcasts), but the Internet has become the primary medium for most distance learning. Although most educators think of distance learning only as courses, there are actually numerous ways to integrate the Internet into the classroom in support of learning. Allen and Seaman (2009) identified three types of online courses:

1. **Blended learning** or **hybrid learning**, where the course is a mixture of online and face-to-face delivery
2. Web-facilitated, where a course uses web-based technology in a face-to-face setting
3. Online, where most or all the content is delivered online

There are four types of general activities that fall under these frameworks: student research, online classroom materials, web-based lessons, and virtual courses and programs. A summary of the instructional benefits of these activities is given in the Top Ten feature.

**Student research.** Students use the Internet to search for materials and information to support their research and production work. Although search engines have become easier and more productive to use for this purpose, students still need help applying what are known as the “Big6” skills, developed by Michael B. Eisenberg and Robert E. Berkowitz (<http://www.big6.com>). These skills are an important foundation to ensure that students make best use of this form of distance learning. The “Big Six” are:

1. Task Definition
2. Information-Seeking Strategies
3. Location and Access
4. Use of Information
5. Synthesis
6. Evaluation

(Big 6 is © Michael B. Eisenberg and Robert E. Berkowitz <http://www.big6.com>.)

**Online classroom materials.** In this type of distance learning, teachers use online materials to help teach themselves and/or their students a topic or skill. The Technology Integration in Action example at the beginning of this chapter is illustrative of this approach.

**Web-based lessons.** In this type of learning, teachers use website resources to structure a curriculum lesson. This is very popular in K–12 education as the lesson and activities easily augment existing curriculum.

**Virtual courses and programs.** Distance courses were popular in higher education long before they caught on at K–12 levels. Since 1996, virtual courses and diploma programs have sprung up around the United States and in other countries (Doering & Veletsianos, 2008; Watson, Murin, Vashaw, Gemin, & Rapp, 2010).

## Current Issues in Distance Learning

As communications became more global and accessible, many in education hoped it would mean better access to high-quality education for all students, regardless of location and economic status. These hopes have not been universally realized, and unexpected problems have occurred, including the widening of the Digital Divide, socialization issues, and the impact of education reform.

**Digital Divide issues.** Greater dependence on the Internet has served to widen still further the Digital Divide. Recent studies show that while more students are using the Internet and other distance resources, children from underserved populations (i.e., low-income and some minority students) still have far less access at home and school than other students (Goldarb & Prince, 2008; Jackson et al., 2008; Wei, Teo, Chan, & Tan, 2011). If this gap persists, it augurs future problems in providing equitable access to the resources distance learning offers.

**Development and socialization issues.** Spending too much time on computers has been cited as harmful to children’s development of relationships and social skills. The American Academy of Pediatricians (AAP), recognizing these potentially harmful effects of overexposure to mass



**TOP TEN**  
**Ways That Distance Resources Support Learning**

The following characteristics of distance resources have the ability to enhance teaching and learning activities in unique ways.

SOURCE	TRACK	SELECTION
Fast access to information	<b>1</b>	Students use the Internet to locate information quickly for classroom research and development projects and educational opportunities.
Access to experts not available locally	<b>2</b>	Internet projects let students tap the expertise of experts at a distance.
Fast communication to groups	<b>3</b>	Websites, email, and blogs help teachers and students send updates and stay in touch with each other and with parents and community members.
Communication resources to support collaboration	<b>4</b>	Email, bulletin boards/conferences, blogs, chats, websites, and other resources make it easier for students and teachers to work together and share products, whether they are in the same physical location or at a distance.
Access to learning materials	<b>5</b>	Teachers download prepared handouts, tests, images, and other materials to use with students; students can use online self-instructional tutorials to surge ahead on a topic.
Access to courses and lessons not locally available	<b>6</b>	Teachers and students can take courses on topics for which teachers are not available at their sites.
Access to education for home-schooled and/or homebound students	<b>7</b>	Students who are at home due to choice, illness, disability, or discipline can take courses and complete degree programs online.
Learning communities support collaboration	<b>8</b>	Teachers and students support and encourage each other and share ideas and materials to advance learning.
Lesson ideas from multiple sources	<b>9</b>	Teachers can locate teaching ideas on any topic from a variety of Internet sites set up for this purpose.
Increased interaction among students and between students and teachers	<b>10</b>	Many educators and students feel that the communication options available in distance courses make it possible for them to interact more than is possible in face-to-face environments.

media (including the Internet), calls for limiting children's use of media (Beresin, 2010).

**Positive and negative impact on education reform.** Many educators predict that distance learning will reform

teaching methods and increase access to quality education. Advocates have been optimistic that the distance learning movement will alter traditional, teacher-centered methods and bring about richer, more constructivist methods. However, recent reports dispute this belief (Savin-Baden et al., 2010;



Students use the Internet to search for materials and information to support their research and production work.

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Tao, Ramsey, & Watson, 2011), finding that distance resources are usually used to support traditional approaches. Virtual K–12 schools are a growing phenomenon, but their impact on educational reform is often hampered by issues such as high dropout rates, as well as disputes over funding and governing policies for maintaining quality. Virtual schooling has also become a political issue, since some educators and parents fear that virtual schools could become the primary vehicle that would allow federal and state funding for private and home-schooled students (Glass, 2009; Roblyer & Davis, 2008). Further, critics question whether current funding is being directed at virtual school programs that are consistently being monitored for quality. It seems regulations and policies to evaluate and ensure continued quality struggle to keep up with the rapid pace of technological advancement and the growth of virtual schools.

**Virtual schooling issues.** Although an increasingly popular strategy, K–12 virtual courses and programs present the following ongoing challenges:

- » **Curriculum alignment**—To be awarded credit, virtual school curriculum standards have to be aligned to state and local standards where the students reside. This is especially difficult when students from a given virtual school come from more than one state.
- » **Teacher certification**—To ensure they are qualified, online teachers must receive certification from a state agency. Schools must either identify one agency or accept teachers from several different certifying agencies.
- » **Accreditation**—Course credit can be granted either by the virtual school or the school district. Accrediting agencies have emerged to certify online schools, but it is sometimes difficult to tell if the agency itself is reliable.

- » **Funding**—Lawsuits have arisen over whether virtual schools should be authorized to use public funds. Some people believe that virtual schools are an attempt to implement home schooling at public expense.
- » **Possible negative consequences**—There is an ongoing dialogue on the possible negative effects of virtual schooling on students' socialization. Also, the dropout rate is usually higher for online courses, and it has become clear that not all students can succeed online with prior help (Rauh, 2011; Scot, Callahan, & Reed, 2008). Successful online students seem to need more than the usual degree of organization skills and self-motivation, as well as better-than-average computer skills. Online students must also be afforded ready and reliable access to technology resources, which may place children in lower socio-economic classes at a disadvantage. While it may expand educational access for many, questions have been raised as to whether distance learning and the choice to attend a virtual school is a realistic option for students in poverty, and if this contributes to widening the opportunity gap in education.

## Current Research and Status of Distance Learning

Though fueled by the popularity of the Internet, the current wellspring of support for distance learning seems unlikely to be just a passing fad. Years of research have confirmed the effectiveness of some forms of distance learning, and studies of other strategies are on the increase. This section captures some current research that indicates how distance learning is helping shape the future of teaching and learning, and the current status of distance learning. In the past, the most popular kind of research compared a distance learning method with a traditional method. However, several other kinds of questions are also proving useful in shaping the impact of distance learning. Findings on these topics are described here and summarized in Table 2.

**Effectiveness of distance learning compared with face-to-face (FTF) learning.** A meta-analysis and review of online learning conducted by the U.S. Department of Education (2010) comparing face-to-face (FTF) and online courses confirmed that students in online courses performed modestly better than those learning face-to-face. Evidence from this meta-analysis does not attribute this gain in learning outcomes to technology alone, however, but instead to a combination and variety of contextual, pedagogical, and technological interventions. Larson and Sung (2009) compared online, blended, and FTF courses, measuring student and faculty satisfaction as well as learning effectiveness. While they did not find any statistically significant difference between the three modes related to these three dimensions,

**TABLE 2** Summary of Research Findings on Distance Learning

Research Topic	Research Questions	Findings
<b>Effectiveness and impact</b>	<ul style="list-style-type: none"> <li>Are distance courses as effective as FTF courses?</li> </ul>	<ul style="list-style-type: none"> <li>No significant overall differences in achievement between distance and FTF courses</li> <li>Asynchronous courses reflect higher achievement than synchronous ones</li> <li>Dropout rate usually higher in distance courses</li> <li>Harder to teach topics that have visual problems and solutions in distance courses</li> </ul>
<b>Course quality</b>	<ul style="list-style-type: none"> <li>What are the characteristics of effective distance courses?</li> </ul>	<p>The most successful courses have:</p> <ul style="list-style-type: none"> <li>High interaction</li> <li>Instructor and other support throughout the course</li> <li>Fewer technical problems and good technical support when problems occur</li> </ul>
<b>Effective distance learners</b>	<ul style="list-style-type: none"> <li>What are the characteristics of students who are effective distance learners?</li> </ul>	<ul style="list-style-type: none"> <li>Mixed evidence on whether single cognitive factors (e.g., self-efficacy) predict success</li> <li>Combination of achievement beliefs, responsibility, self-organization ability, and technology skill/access appears to predict student success</li> </ul>
<b>Effective distance instructors</b>	<ul style="list-style-type: none"> <li>What are the characteristics of effective distance instructors?</li> </ul>	<p>Effective distance instructors have good:</p> <ul style="list-style-type: none"> <li>Course planning and organizational skills specific to distance environments</li> <li>Verbal and nonverbal presentation skills specific to distance learning situations</li> <li>Ability to involve and coordinate student activities among several sites</li> <li>Communication and classroom organizational skills</li> <li>Collaborative work with others to produce effective courses</li> <li>Ability to use questioning strategies</li> </ul>
<b>Cost effectiveness</b>	<ul style="list-style-type: none"> <li>What cost factors enter into preparing and implementing distance education programs?</li> <li>How do we determine cost effectiveness?</li> </ul>	<ul style="list-style-type: none"> <li>Costs factors include technology, transmission, maintenance, infrastructure, production, support and personnel</li> <li>Distance education becomes more cost effective when resources are used more efficiently and with more courses</li> </ul>

they did find that both blended and online learning were perceived by students as being slightly more motivating and more apt to improve their critical thinking skills. In addition, **asynchronous** courses, or those in which information and messages are left for the receiver to read later, tended to show greater gains than **synchronous** ones, in which communications are sent and received immediately (Bernard et al., 2009; Offir, Lev, & Bezalel, 2008). There is also no doubt that distance students tend to drop out at higher rates than students in FTF courses (Pittenger & Doering, 2010; Pontes, Hasit, Pontes, Lewis, & Siefiring, 2010). There are numerous debates related to online learning today—engage yourself with the Hot Topic Debate feature for this chapter.

**Course characteristics that affect success.** Some studies focus on course factors that correlate directly to dropout rates in distance learning courses (Bollinger, Supanakorn, & Boggs, 2010; Michinov, Brunot, Le Bohec, Juhel, & Delaval, 2011). However, many researchers still agree with Wilkes and Burnham (1991) that course success should be measured by more than just endurance and achievement, since “highly motivated learners may be willing to endure almost (anything) to achieve a passing grade” (p. 43). Therefore, the majority of studies in this area focus on attitude surveys of students who complete distance learning courses. A study examining a statewide virtual high school conducted by Oliver, Osborne, Patel, and Kleiman (2009) indicated that

### CAN STUDENTS LEARN AS WELL ONLINE AS FACE-TO-FACE?

*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.*

One of the biggest debates and discussions in distance education is if learning online is as effective as face-to-face (FTF). As Clark (1982), Saettler (1990), and others note, there have

been decades of media comparison studies in which student outcomes were compared in classrooms using and not using various technologies. Similar studies have been done comparing distance learning and traditional learning (Bernard et al., 2009; Russell, 1997), yielding the same results: no significant differences. However, we also know that the dropout rate is higher in distance learning. Many recent studies report the quality and experiences of student learning online are impacted by issues ranging from the amount of interaction with the instructor (Guller, Durndell, & Ross, 2008), to the type of media used. If researchers are correct that the learning medium or distance format makes no difference in learning outcomes, why is the dropout rate so high? Are all students really able to learn well online?

online students value high levels of interaction and feedback from teachers, content delivered in multiple modalities, and a mix of opportunities to communicate both synchronously and asynchronously with others. Researchers agree that the handful of factors described here are the major contributors to course satisfaction (Beauchamp & Kennewell, 2010; Robinson & Sebba, 2010; Scot et al., 2008).

» **High interaction**—Though some studies find that the convenience of distance learning means more to students than teacher interaction does (Offir et al., 2008), the single greatest determinant of satisfaction across studies is the amount of interaction between teacher and students (Beauchamp & Kennewell, 2010; Clayton, Blumberg, & Auld, 2010; Slagter van Tryon & Bishop, 2009). An in-depth study of K–12 virtual school teachers' beliefs and practices conducted by DiPietro (2010) indicated that increased interaction with the teacher and others leads to increased perceptions of students' engagement with the content, and ultimately, a more positive learning experience. Maintaining high levels of interaction is critical in order to maintain the self-motivation necessary for success in distance learning courses. Positive communications and interactions among students must be closely monitored and maintained, however, as

negative interactions can have the opposite affect on engagement and motivation. But, as is typical of distance learning and traditional classes alike, smaller class size can determine students' perception of interactivity and, therefore, satisfaction with distance learning instruction. Jones, Warren, and Robertson (2009) and Colucci and Koppel (2010) suggest that meeting students face-to-face for the first class meeting helps establish a rapport that can lead to better interaction throughout the course.

» **Support during the course**—Many studies show that students value and profit from teacher and other support during their course experiences, from registration through course activities and evaluation. DiPietro (2010) observed that supportive interactions help establish a sense of community among learners, resulting in both increased engagement and motivation. In fact, Slagter van Tryon and Bishop (2009) found that a lack of community among distance learners can decrease interaction and negatively affect course satisfaction. McBrien, Cheng, and Jones (2009) find that feelings of isolation or disconnectedness from the teacher and classmates, as well as frustration with technology problems, can also negatively affect course satisfaction.

» **Minimal technical problems**—Consistent evidence exists that technical problems can doom the best-planned course (Ko & Rosen, 2010; McBrien et al., 2009). Successful courses are those that minimize technical problems so that the student can focus on the learning rather than on computer and technical issues. Not having to mediate technology problems also frees the teacher to spend more time on instruction and accommodating student needs.

**Virtual schooling research.** *Keeping Pace with K-12 Online Learning* is an annual report on the state of online K–12 education nationwide within the United States (Watson et al., 2010). It draws data from web-based surveys, phone interviews, and Internet research. The 2010 report divides online education into four categories: state virtual schools, full-time online schools, single-district online programs, and consortium (multi-district) programs.

State virtual schools typically offer supplemental education to students within a specific state and are often overseen by a state education agency. As of 2010, they operated in 39 states, with about 450,000 students participating nationwide. Growth of enrollment in these schools is small with the exception of two states, North Carolina and Florida, which saw huge gains in enrollment in the 2009–2010 school year versus the previous year. Characteristics of state virtual schools include the following:

- » Enrollment varies from several thousand to about 16,000 students.
- » A state education agency typically oversees the program, and funding primarily comes from the state legislature.
- » Courses are focused on high school students, with some offerings provided to middle school students as well.
- » Most programs provide supplemental education opportunities only; even where full-time schooling opportunities are offered, few or no students are participating.
- » Grades are often determined by the state virtual school, with credit for the course provided by individual school districts.

Full-time online schools are primary education providers that offer online learning programs for students across multiple school districts, often an entire state. Twenty-seven states plus Washington, DC, had at least one full-time online school in 2010. These schools are growing in popularity in many states, though the overall population of students nationwide still remains relatively small at around 200,000. Characteristics of full-time online schools include the following:

- » Enrollment varies from several hundred to several thousand students.

- » Most are set up as charter schools, and many are connected with a larger national organization.
- » Programs typically serve students across all grade levels statewide.
- » Funding primarily comes from state public education funds, on a per-student basis.
- » Student achievement is tracked and accounted for as dictated by state guidelines.

Single-district and consortium (multi-district) online programs primarily offer supplemental education for students, and are often part of **hybrid learning** opportunities that allow students to blend online and face-to-face learning. According to *Keeping Pace*, these schools comprise the “fastest growing segment of K-12 online learning” (p. 6). Characteristics of such programs include the following:

- » Typically, programs provide supplemental education opportunities only, and online offerings are blended with face-to-face offerings.
- » Many target at-risk students, and most focus on high school students, with some opportunities for middle school students.
- » Funding usually comes from a district’s existing public funds for face-to-face learning.
- » Districts range in size from about 3,500 students to over a million students.

**Characteristics of successful distance learners.** Some researchers have tried to identify student capabilities or other factors that could predict whether a student might drop out, be less satisfied, or not perform as well in an online activity. A study conducted by Patterson and McFadden (2009) comparing the student attrition rates of online and traditional learning programs indicated that online students drop out at a significantly higher rate than campus-based students. Findings of the study suggest that there is no single theory that can fully explain student attrition in distance learning; students likely drop out due to a combination of variables.

Research exploring success in distance learning varies as well. Hypothesized characteristics of successful distance learners include self-motivation and ability to structure one’s own learning (Robinson & Sebba, 2010), previous experience with technology (Johnson, Gueutal, & Falbe, 2009), good attitude toward course subject matter (Hung, Chou, Chen, & Own, 2010), and locus of control (Vandewaetere & Clarebout, 2011). Studies disagree on whether single cognitive factors can predict success. Vandewaetere and Clarebout (2011) found that higher internal locus of control relates to student satisfaction, motivation, and learning outcomes.

A study conducted by Damianov et al. (2009) suggested that spending more time online can predict whether students will be successful in online learning environments. There appears to be a lack of consensus as to whether students' computer self-efficacy (i.e., belief in their ability to use computers effectively) could predict their degree of satisfaction in online courses and whether it positively influences learning outcomes. In a comprehensive review of empirical research, Moos and Azevedo (2009) reported that computer self-efficacy is related both to learning outcomes and to learning processes with computer-based learning environments. There are an equal amount of studies that support a correlation between increased computer self-efficacy and improved learning outcomes as those that refute this finding. Gebara (2010) found no correlation between general student self-efficacy and satisfaction, but did determine that interactions with and feelings of connectedness to the teacher correlate highly with student satisfaction and achievement in online courses.

Roblyer and Davis (2008) found that a set of four characteristics working in combination (achievement beliefs, responsibility, self-organization ability, and technology skill/access) offered a better prediction of whether virtual high school students will succeed in online courses. Similarly, Barbour and Reeves (2009) concede that successful virtual high school students are independent learners with high levels of intrinsic motivation, literacy, time management, and technology skills. There are numerous issues in online learning that impact student learning. View the Adapting for Special Needs feature for this chapter to learn what an instructor can do to assist learners with special needs.

**Characteristics of effective distance learning instructors.** Fish and Wickersham (2009) emphasize that distance learning instructors need different skills than instructors for traditional courses do, and the review of the research reveals several areas of unique competence, all of which require experience with distance learning environments:

- » Course planning and organization that capitalize on distance learning strengths and minimize constraints
- » Verbal and nonverbal presentation skills specific to distance learning situations
- » Collaborative work with others to produce effective courses
- » Ability to use questioning strategies
- » Ability to involve and coordinate student activities among several sites

**Research on cost effectiveness of distance learning.**

A typical discussion at academic institutions is the start-up cost of delivering distance learning. Normally one thinks that it is less expensive to deliver distance learning, but we cannot forget about the initial investment that is needed.

- » **Technology**—Do you have the hardware and software that are necessary to deliver distance learning?
- » **Transmission**—Do you have adequate Internet access to deliver quality distance learning?
- » **Maintenance**—Do you have a dedicated technology specialist to assist with maintenance and updating issues?



## ADAPTING FOR SPECIAL NEEDS

### Internet Resources

**A**s the Internet becomes increasingly important as a way of obtaining information and education, it is imperative that individuals with disabilities have full access to all that the Internet offers. Advocates for web accessibility have undertaken a series of activities (e.g., federal laws, technical standards, guidelines, tools, and training workshops) designed to ensure universal access.

A fundamental problem with inaccessible web design can be traced to the lack of awareness and knowledge about disability. For example, not realizing that information presented in an audio file is of no use to a deaf individual is a critical insight. Likewise, the experience of trying to navigate a web page if you are blind provides important sensitivity to the issues of accessible design.

To gain insights about the importance of accessible web design, explore the following resources:

- » **WebAIM Simulations** (<http://webaim.org/simulations>)—Experience what it is like for someone with a disability to navigate the web
- » **Introduction to Web Accessibility** (<http://www.webaim.org/intro>)—Learn more about the importance of accessible web design
- » **Functional Accessibility Evaluator** (<http://html.cita.illinois.edu/tools>)—Test a web page to evaluate its accessibility

*Contributed by Dave Edyburn*

- » **Infrastructure**—Is there a foundational network and telecommunications infrastructure located at originating and receiving sites?
- » **Production**—Do you have technical and personnel support to develop/adapt teaching materials?
- » **Support**—Do you the necessary support for delivering distance learning (costs of administration, registration, advising/counseling, local support, facilities, and overhead)?
- » **Personnel**—Do you have the necessary instructors and support staff?

with the **World Wide Web (WWW)**, the latter really is a subset of the Internet system. The WWW is an Internet service that links sites around the world through **hypertext**, texts that contain links to other texts. Everyday many people use a web browser to load websites that are connected to each other via the WWW, and in this way, they “travel” around the Internet from site to site.

The very first **web browser** was *Mosaic*, introduced in 1993. Its highly graphic nature caused an explosion of Internet use by the following year. The most common web browsers today are Safari, Firefox, and Internet Explorer. Web browsers are no longer just found on a desktop or laptop computer, but are now found on mobile devices such as smart phones and tablets.

## THE INTERNET

The Internet has made such a difference in our society that it is difficult to remember when we did not depend on it for communications, instruction, and even entertainment. Yet today’s educational uses of the Internet bear little resemblance to its original purpose.

### A Quick look at the History

The U.S. Department of Defense (DOD) developed the first version of the Internet during the 1970s to allow quick communication among researchers working on DOD projects in about 30 locations. The DOD also saw it as a way to continue communications among these important defense sites in the event of a worldwide catastrophe such as a nuclear attack. Because these projects were funded by the DOD’s Advanced Research Projects Agency (ARPA), the network was originally called **ARPAnet**.

In the 1980s, just as desktop computers were becoming common, the National Science Foundation funded a high-speed connection among university centers based on the ARPAnet structure. By connecting their individual networks, universities could communicate and exchange information in the same way the DOD’s projects had. However, these new connections had an additional, unexpected benefit. A person accessing a university network from home or school could also get access to any site connected to that network. This connection began to be called a gateway to all networks, and what we now call the Internet was born.

Networks connect computers to allow users to share resources and exchange information easily. The Internet, or the Net, as it is commonly known, has been called the ultimate network or “the mother of all networks” because it is a network of networks. It is a way for people in network sites all over the world to communicate with each other as though they were on the same local-area network. The name Internet means literally “between or among networks.” Though most people think of the Internet as synonymous

### Controversies and the Internet

As the Internet has become a society-wide tool, the Internet has also spawned its share of society-wide debates, problems, and controversies. In many ways, it is a reflection of the best and worst qualities of our society. Problems with equity and human behavior (and misbehavior) have already begun to emerge. Although there are numerous issues, five potential problem areas are discussed here, along with strategies that educators can use to make the Internet a safer, more worry-free place for teaching and learning.

**Potential problem #1: Accessing sites with inappropriate materials.** Like a big-city bookstore, the Internet has materials that parents and teachers may not want students to see, either because they are inappropriate for an age level or because they contain information or images considered objectionable. Yet the Internet is designed to make information easily obtainable, and unfortunately, such materials can be accessed all too easily by accident. For example, up until only a few years ago, only the domain designator (such as .gov, .com, and .info) differentiated the website for our nation’s Executive Branch (<http://www.whitehouse.gov>) from a pornography site. Because it is so easy to access these sites, preventing students from accidentally visiting these pages is more than difficult.

The Children’s Internet Protection Act, signed into law on December 21, 2000, is designed to ensure that libraries receiving federal e-rate funds take measures to keep children away from Internet materials that could be harmful to them (McNabb, 2001). Most schools have found that the best way to prevent access to sites with inappropriate materials is to install firewall hardware and/or filtering software on individual computers or on the school or district network that connects them to the Internet. **Firewall software** (e.g., *Norton Internet Security* and *SpyWare Doctor*) protects a computer from attempts by others to gain unauthorized access to it and also prevents access to certain sites. **Filtering software**

(e.g., *Cyber Patrol* and *Net Nanny*) limits access to sites on the basis of keywords, a list of off-limit sites, or a combination of these. Although there is software and hardware to prevent students from accessing inappropriate material, nothing is foolproof and/or without issues. For example, students and/or teachers wanting to use YouTube within the classroom for appropriate material many times find that it is blocked. Also, whenever a piece of software or individual is in charge of filtering content, content that is important for learning may be blocked and controlled.

**Potential problem #2: Safety and privacy issues for students.** Social networking sites (SNS) are online locations that allow users to upload their own content, meet and connect with friends from around the world, and share media and interests. Although most SNSs are blocked in schools today, the dominance of them outside of school and the lack of experience most students have may put young people at special risk. Carr (2011) reported that Facebook “boots” approximately 20,000 underage users per day, and nearly half of all 12-year-olds in the United States are using social network sites, despite not meeting the minimum age requirement of 13 years old. Students can be impacted negatively from the Internet in many ways, including:

- » **Online predators**—Many times young people tend to believe everything they hear and read. Therefore, in a variety of online discussion rooms or chat rooms (online locations where people can drop in and exchange messages in real time), they may not consider the possibility that a 12-year-old named “Mary” may actually be a 50-year-old man. Students should be told never to provide their complete names, addresses, or telephone numbers to any stranger they “meet” on the Internet, and they should report to teachers any people who try to get them to do so.
- » **Sales pitches aimed at children**—This is a problem similar to that posed by television commercials. Many Internet sites have colorful, compelling images that encourage people to buy. Young people may make purchase commitments they cannot fulfill.
- » **Privacy issues**—In their web products, teachers should be careful not to identify students with last names, addresses, and other personal information. Another privacy issue surrounds the use of cookies, or small text files placed on a hard drive by a web server contacted on the Internet. The purpose of cookies is to provide the server with information that can help personalize web activity to your needs, but cookies also may track behavior on the Internet in ways that violate privacy.
- » **Cyberbullying**—The practice of using technology to harass, threaten, embarrass, or target another person

(see <http://kidshealth.org/parent/positive/talk/cyberbullying.html>) has become an acknowledged problem. Cyberbullying is the online version of regular school bullying and can produce the same harmful consequences to young people. Several sites have been set up to document and combat this problem (see <http://www.cyberbullying.us> and <http://www.stopcyberbullying.org>).

**Potential problem #3: Fraud on the Internet.** Even today, after all the advances in the Internet and technology, fraud on the Internet still exists. One must also be aware that, although the Internet is becoming more secure for credit card use, online consumers, teachers, and even students must be sure to purchase products only from well-known, reputable sites that offer a secure server. Secure servers have special programs to prevent outside monitoring of transactions. The uniform resource locator (URL) for a secure server usually begins with “https” instead of the usual “http,” and has a symbol of a lock in the web browser.

**Potential problem #4: Computer viruses and hacking.** Viruses are programs written for malicious purposes. They come in several varieties and are named according to the way they work—for example, worms, logic bombs, and Trojan horses. Two ways to get viruses on your computer from the Internet are through email attachments and downloaded files.

- » **Email attachments with viruses**—Although not as common as five years ago, email attachments can contain viruses, and when files are exchanged many senders are not even aware they are sending the emails. However, if a computer contains a virus programmed to attach itself to files, the virus can inadvertently be sent along with the file. When the person receiving the attachment opens it, the virus transfers to his or her computer.
- » **Downloaded files and programs with viruses**—As with email attachments, viruses can attach themselves to files and programs and be received along with the item being downloaded. Figure 1 identifies strategies to address these virus problems.

An additional problem is attacks by **hackers**, those who seek to gain unauthorized access to computer systems for the purpose of stealing and corrupting data. Using effective firewalls can prevent hackers from entering the system. However, many schools are finding that firewall software and hardware designed to protect users from harmful sites also can have the undesirable side effect of preventing students and teachers from accessing harmless, useful sites. Occasionally, firewalls also can prevent those outside a network from reaching



## FIGURE 1 Strategies to Prevent Computer Viruses

<b>Strategy #1:</b>
<b>Keep virus protection software up to date</b> —Maintain, use, and frequently update your virus protection software.
<b>Strategy #2:</b>
<b>Download only from reputable sites</b> —Avoid shareware programs, a frequent source of attached viruses.
<b>Strategy #3:</b>
<b>Never open email attachments from unknown senders.</b>
<b>Strategy #4:</b>
<b>Never open email attachments until you confirm their intent</b> —Some viruses are programmed to send emails and attachments automatically through someone's email program and infect the computers of the recipients. If you weren't expecting a file from the person, do not open the attachment until you can confirm they sent it.

users of the network. School systems find firewalls to be an essential, but problematic, component of being part of the web community and a topic of debate as far as who makes the call regarding what should and should not be blocked and the impact it has on teaching and learning.

### Potential problem #5: Copyright and plagiarism issues.

The Internet is such a rich and easy-to-access source of documents, images, and other resources that it sometimes is easy to forget that many of these resources are copyrighted and protected by U.S. copyright laws. Also, the growing wealth of written products available on the Internet makes it all too easy for students to locate material and use it without crediting the author, or even to turn in whole papers as their own. See Figure 2 for strategies to address these concerns.



## USING THE INTERNET FEATURES AND TOOLS: NAVIGATION

Using the Internet has become a common daily occurrence for many. At the same time, a close look at what and how to use the many facets of this tool is necessary. From the term URL to social networking sites, an in-depth look will provide you with the necessary tools and skills.

### Using Uniform Resource Locators (URLs)

Our use of the Internet depends on the use of common procedures or Internet protocols that allow computers to

## FIGURE 2 Strategies to Address Copyright and Plagiarism Problems

<b>Strategy #1:</b>
<b>Teach the rules</b> —Teach students what plagiarism is, why it is wrong, what is permitted, and what is not.
 <ul style="list-style-type: none"> <li>• <b>If the site clearly is copyrighted</b>, request permission from owners.</li> <li>• <b>If the site has no copyright statement</b>, reference the site by its URL and owner name.</li> </ul>
<b>Strategy #2:</b>
<b>Use sites to check for and prevent plagiarism.</b>
 <ul style="list-style-type: none"> <li>• <b>Plagiarism prevention websites:</b> <a href="http://www.turnitin.com">http://www.turnitin.com</a> and <a href="http://www.safeassign.com">http://www.safeassign.com</a></li> </ul>

Source: Turn It In logo used by permission of iParadigms, LLC.

communicate with each other despite differences in programs or operating systems. One important protocol is the manner of listing website addresses. Just about every home in the world has an address so that people can find it and make deliveries of mail and other items. Each place you “visit” on the Internet also has an address, for many of the same reasons. However, the Internet is less tolerant of mistakes in an address than is the U.S. Post Office! Each address must be entered exactly, with every punctuation mark in place, or it will not work.

Internet addresses are called **uniform resource locators**, or **URLs**. Look at the example URL shown in a browser window in Figure 3. The line where the URL is entered is called the address line. The last three letters in the address line constitute what is called a **domain designator**, which typically indicates the type of content one would find at the website. The most common designators are: .com (commercial site), .gov (government), .net (networks, Internet service providers), .edu (higher education institutions), and .org (non-commercial organizations). The U.S. nonprofit organization that sets up domain names is the Internet Corporation for Assigned Names and Numbers (ICANN). In 2011, it announced that it would allow expanding the number of domain names from the current 22 beginning in 2012. For example, a company such as IBM could have its own domain name of .ibm. You can learn more about ICANN at <http://www.icann.org>.

**Optional parts of a URL.** If an organization is a large one, it may have more than one server, or it may split up a large server into subdomains. When this is done, the domain

## FIGURE 3 Parts of a URL

Address line for URL



Three required parts of every URL (although it can have more optional ones):

**http://www.nasa.gov**

①                      ②                      ③

- ① Each web page address begins with **http://**, which stands for **HyperText Transfer Protocol (HTTP)**.  
The "http://" shows it is an Internet address.  
(Most, but not all, addresses contain **www**, which stands for **World Wide Web**.)
- ② The next part of the address here is **nasa**, the name of the computer or *server* to which you connect. Every server on the Internet has an assigned label called the *domain* name. **nasa** shows that this computer belongs to the National Aeronautics and Space Administration, a government agency with a wealth of resources on its website.
- ③ Finally, another required part of the domain name, the *domain designator*, tells what kind of group owns the server. Some example domain designators are:

**org** = organization  
**gov** = government agency  
**k12.us** = public schools  
**mil** = military agency

**com** = business  
**edu** = university  
**net** = network  
**aus** = Australia

name will have more parts. For example, the University of Minnesota has a website: <http://www.umn.edu>.

Optional parts called subdomains usually come before a domain designator. For example, the website for the Learning Technologies Media Lab is shown at a certain location on the UMN server indicated by the subdomain "lt": <http://lt.umn.edu>.

**Two URL uses.** Two things to learn about URLs are how to locate them and how to read them.

- » **Locating URLs**—If you want to visit a site, but you don't know its URL, one way to find it is to make an educated guess. For example, let's say you want to find the website for the National Council of Social Studies. Since you know it probably will have an ".org" designator, and organizations usually use their initials in URLs, a good guess would be <http://www.ncss.org>.
- » **Reading URLs**—If someone gives you a URL, very often you can tell what and where it is by reading its parts. Look at an example:

<http://www.noaa.gov>

If you knew that the URL someone gave you was one on the subject of weather, you might guess this is for the

National Oceanic and Atmospheric Administration (NOAA), a government agency that offers students and teachers a wealth of up-to-date information on the weather.

## Navigating the Net

You can move around from web page to web page on the Internet by using four different options: clicking (laptop) or tapping (tablet or smartphone) on links, using the Forward and Back buttons, using the History bar or button, and using Quick Response (QR) codes.

**Method #1: Navigating with links.** You can "travel" on the Internet by clicking or tapping **links** (also known as **hot links** or hot spots), text or images that have been programmed into the web page to send your browser to another location on the Internet, either within the site or to another site, when you click on them.

How do users know when images are links? Many times they simply don't, especially with the recent introduction of tablet computers and smartphones. However, normally when they pass a cursor over an image (without clicking) and the pointer turns into a "browser hand," that image is a link.

**Method #2: Navigating with buttons.** Forward and Back buttons are available on browser menu bars. This has been the most common way to navigate back and forward to a previously viewed page.

**Method #3: Navigating with the “History.”** Although not as common for navigation, every browser has a History section where a user can navigate randomly (rather than just forward or back) to previously visited sites without having to retype a URL address into the address bar. Simply open the address bar and scroll down to select and visit any of the pages recently visited.

**Method #4: Navigating with Quick Response (QR) codes.** The newest method of getting to Internet sites and web-based resources quickly is by scanning QR codes. These are small, two-dimensional barcode-like images (see Figure 4) that can be scanned with a mobile device such as a smart phone in order to send the user to an Internet site. QR codes are becoming ubiquitous in all areas of society, including education. Teachers use them to help students go quickly to online educational materials such as videos, worksheets, supplements to textbooks, or school-related information. To create QR codes, users can go to a free code-generator site such as Kaywa (see <http://qrcode.kaywa.com>). QR code readers are needed to scan QR codes, and free code-reader apps may be downloaded from the Internet.

## Using Bookmarks, Favorites, and Online Organizers

You can visit so many sites on the Internet that you quickly lose track of where you found a valuable site on a certain topic. You could write all of them down, but a quicker way to go to such sites is to let a feature in your browser help you create a list or use an online organizational tool. This browser-based list is called a **Bookmarks file** (in Firefox and Safari) or **Favorites file** (in Internet Explorer).

**Adding a Bookmark or Favorite.** Making a Bookmark or Favorite is very simple. Just travel to the site, and when it

### FIGURE 4 QR Code for Pearson’s MyEducationLab



is on the screen, go to the Bookmarks or Favorites menu at the top of the browser frame and select Bookmark (the names of these options may vary, depending on the version of the browser).

**Organizing a Bookmarks or Favorites file.** For a Bookmark collection to be most useful to its creator and others, it should be organized into sections, much like a library or any collection of materials. After Bookmarks are created, they can be organized into categories of related items.

**Using an online organizer.** The website delicious (see <http://del.icio.us>) allows users to access their Bookmarks at any location by saving the website URLs online in one place. At this site, they can also bookmark pages for their friends and see what other people are bookmarking. A recent competitor to delicious is ZigTag (see <http://zigtag.com>), which categorizes bookmarks through the use of tags and also allows users to share those bookmarks with friends. To set itself apart, ZigTag claims its service is “intelligent” and uses semantic technology to understand the meaning of tags.

## Basic Internet Troubleshooting

Like most technologies, the Internet presents its share of “head scratchers.” The majority of these errors and problems can be corrected easily; others require more complicated fixes or adjustments. Two of the most common difficulties for Internet users are discussed here.

**Problem type #1: Site connection failures.** After entering the URL, the site won’t come up on the screen. This is the most common problem people encounter; it may occur because of URL syntax errors, problems with the local or domain server, bad links, or firewall issues. The error message for each problem indicates the cause.

» **URL syntax errors**—As mentioned earlier, each dot, punctuation mark, and letter in a URL has to be correct, or the site will not load. The most common error message for this problem is: “unable to locate the server. Please check the server name and try again.” If this message appears, check the URL syntax and make sure you have not done any of the following:

- Confused the letter “l” with the number “1”
- Confused the letter “O” with the number “0”
- Confused the hyphen “-” with the underscore “\_”
- Confused the forward slash “/” with the backward slash “\” in “http://” or in suffixes
- Omitted a required punctuation mark
- Misspelled a part of the URL
- Used the wrong domain designator (e.g., edu instead of org)

Many URL errors occur in suffixes that follow the domain designator. Try omitting all suffixes beyond the slash and going directly to the main part of the URL. The main page may show the links you want, or the site may have a built-in search engine you can use.

- » **Local or domain server down**—If you have checked the URL syntax and are positive it is correct, it may be that the server that hosts the website is not working temporarily. It may have a technical problem, or it simply may be down for regular maintenance. In this case, you may get an error message like the one shown previously. Wait an hour or two, and try it again.
- » **Server traffic**—A more rare cause of connection failures is that the server handling Internet traffic for the network or for users in the geographic region is not working properly. Error messages say: “Failure to resolve domain error. Try this site again later” or “Page has no content.”
- » **Bad or dead links**—If a URL repeatedly fails to connect and you are sure the syntax is correct, the site may have been taken off the Internet. This is known as a bad or dead link. If this is the case, you may get the same error message given previously, or the site may provide a message that says: “Bad link.”
- » **Firewalls**—Sometimes a site will not connect because a network’s firewall blocks it. If you think your network’s firewall is blocking your access to a site in error, contact your network administrator and request that this be adjusted.

**Problem type #2: Feature on the site will not work.** If an Internet site indicates that it has a special feature, such as an animation, a movie, or sound, but it will not work, there are three possible causes:

- » **Plug-in required**—Although not as common as in the early days of web browsers, it may be that the computer does not have the special program or plug-in required to play the movie or sound. Usually, if a special plug-in is needed, the site will have a link to a location where you can download the plug-in and install it on your computer.
- » **Compatibility errors**—The Internet works because there are agreements in place about how to make various machines and programs “talk” to each other. However, sometimes differences exist between operating systems or versions of software that make them incompatible. One of the most recent issues is the inability for Adobe *Flash* to work on Apple devices such as the iPhone or iPad. This issue is a result of two companies not agreeing on common standards, but it is still a major compatibility error that teachers should be aware of.

## USING INTERNET FEATURES AND TOOLS: SEARCHING AND STORING

Before the Internet, it was difficult to locate specific resources or items of information. Now there is so much information that companies have developed special searching programs to help us locate things. These searching programs are called **search engines**. Some popular search engines and how to use them are described here.

### Types of Search Engines

According to SearchEngineWatch, a site with information on all available search engines, there are many kinds of search engines. Check out SearchEngineWatch to learn about various types of sites (e.g., filtered ones for kids, social networking search engines). Two commonly cited types of search engines are:

- » **Major search engines**—The most popular ones cited by SearchEngineWatch are:
  - **Google:** <http://www.google.com>
  - **Yahoo!:** <http://www.yahoo.com>
  - **Bing:** <http://www.bing.com>
- » **Metacrawlers**—These programs use more than one search engine at the same time to locate things. The top five cited by SearchEngineWatch are:
  - **Dog Pile:** <http://www.dogpile.com>
  - **Vivisimo:** <http://Vivisimo.com>
  - **Kartoo:** <http://www.Kartoo.com>
  - **Mamma:** <http://www.mamma.com>

### Search Strategies

Search engines can be used in two ways:

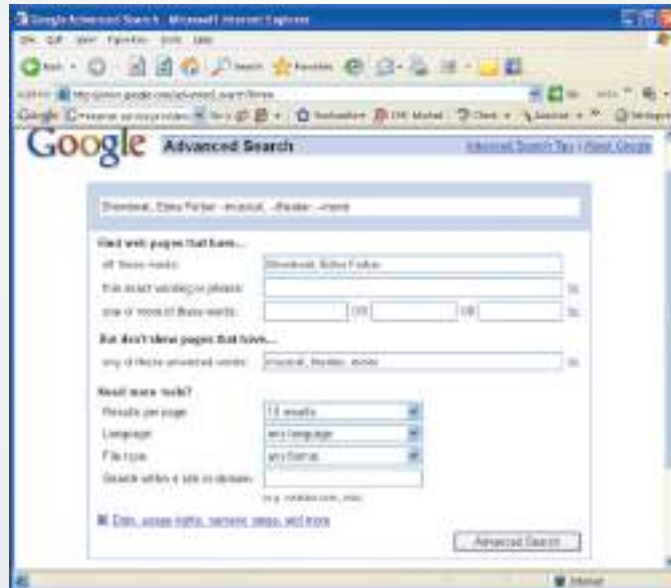
- » **For subject index searches**—The search engine site provides a list of topics you can click on.
- » **For keyword searches**—Type in a combination of words that could be found in the URLs of the sites or documents you want. When searching Google, you are doing a keyword search. Just type in the search word or phrase, and the search engine displays a list of websites whose URLs contain the word or phrase. The pages listed as results of the search are sometimes called **hits**. Try out a keyword search in the Figure 5 exercise.

## FIGURE 5 Search Engine Strategy: Using Keywords

### Using keywords

**Problem:** You want to know about literary criticism on the novel *Showboat* by Edna Ferber. A keyword search with the phrase Edna Ferber's "Showboat" yields hundreds of hits on the music and the movie. However, you want to know ONLY about the book. Try the following:

- » Go to the Google search engine site: <http://www.google.com>.
- » Click the Advanced Search button on the right.
- » Fill in the terms *Showboat* and *Edna Ferber*, separated by commas, as shown below in the all these words box.
- » Fill in the terms *musical*, *theater*, and *movie*, separated by commas, as shown below in any of these unwanted words box.
- » Review the list of results.



Source: Google™ is a trademark of Google, Inc. Reprinted by permission.

## Storing and Interacting with Files Online

Although the use of USB flash drives and portable hard drives still remains today, the use of them may become much less in the near future. Recently, **cloud computing** has entered mainstream society. Cloud computing refers to using software stored outside ones' own computer on servers that are accessed through the Internet. Thus, instead of needing to install applications and store files on your local computer or mobile device, they are stored on a server over a network that is available at all times (see Figure 6). For this reason, the days of forgetting a file at home are gone, and the days of school technology specialists needing to install applications on each individual computer throughout the school may be history.

In 2011, Apple introduced their cloud computing service with the introduction of *iCloud*. *iCloud* is purported to store a user's music, photos, apps, documents, and more, and is automatically synched between a user's devices. *iCloud*

is not the first, as there is the Amazon *Cloud Drive* and the Google *Cloud*. There are also other ways in which files can be stored and shared online. Another very popular service is *DropBox*. Like the so-called "cloud" services, *DropBox* provides a similar service, allowing users to store and share files online between any computer or mobile device.

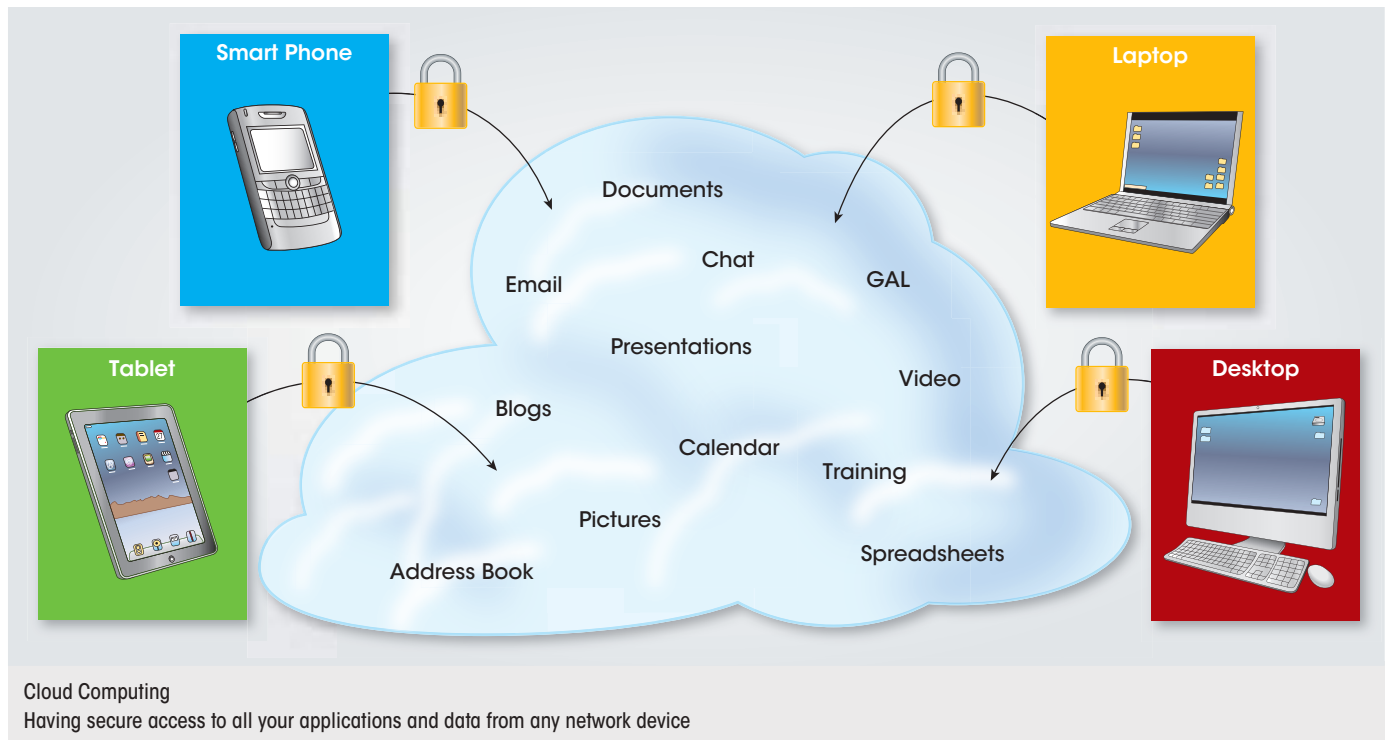
## USING INTERNET FEATURES AND TOOLS: COMMUNICATING

Increasingly, the Internet has become a primary form of communication for teachers and students, replacing traditional channels such as sending letters and making telephone calls.

### Email

Electronic mail (email) is the most common way to exchange personal, written messages between individuals or small groups. Email may be sent via a program (e.g., Microsoft

## FIGURE 6 Cloud Computing



Source: Based on [http://en.wikipedia.org/wiki/Cloud\\_computing](http://en.wikipedia.org/wiki/Cloud_computing). Under Creative Commons license, <http://creativecommons.org/licenses/by-sa/3.0/deed.en>.

Outlook, Mozilla Thunderbird) or through capability built into an Internet browser. This versatile medium supports a variety of classroom activities. Researchers have found that email not only has great potential to improve communications among students, teachers, and parents (Legg & Wilson, 2009; Sheer & Fung, 2009), but it can also improve students' writing.

The etiquette guidelines that govern behavior when communicating on the Internet have become known as **netiquette**. Netiquette covers not only rules of behavior during discussions but also guidelines that reflect the unique electronic nature of the medium. Netiquette usually is enforced by fellow users who are quick to point out infractions of netiquette rules. A summary of netiquette rules in Figure 7 is based on published sources, such as Shea's (2004) online book, *Netiquette*.

### Tweets, Bulletin Boards, Blogs, and listservs

Four kinds of communication take the form of asynchronous (not in real time) messages rather than synchronous (real-time) exchanges: Twitter, bulletin boards, blogs, and listservs (lists).

**Tweets.** **Tweets** are text-based posts that can be up to 140 characters that are posted within a person's profile page.

They are part of a social networking and microblogging service known as Twitter. Tweets can be public or restricted depending on how a user sets their profile. Tweets consist of a **hash tag**, or a prefix consisting of a pound sign (#) and a topic name, followed by a message of up to 140 characters. Hash tags allow others to identify posts and create their own messages on the same topic. For example, when Apple founder Steve Jobs died, people on Twitter could express condolences by sending messages with the hash tag #rip-stevejobs. Twitter just turned 5 years old and has 200 million users that use it for everything from wishing someone a happy birthday to bringing groups together around democratic issues. Gross (2011) noted that Twitter has changed the way we communicate by making the flow of information faster and by making "thought leaders" instantly able to put thoughts in front of thousands of people. Although many people do tweet, students between the ages of 12 and 17 do not use Twitter in large numbers—just 8% of online teens ages 12–17 say they ever use Twitter (Lenhart, Purcell, Smith, & Zickuhr, 2010).

Walsh (2010) identified 100 ways to teach with Twitter by locating numerous articles that discuss how Twitter has been used in education. Ten of these 100 ways were identified by blogger Steve Wheeler (2009), where he noted the following:

1. "Twit Board"—Notify students of changes to course content, schedules, venues, or other important information.

## FIGURE 7 Netiquette: Rules of Behavior on the Internet

### Identify yourself:

- Begin messages with a salutation and end them with your name.
- Use a signature (a footer with your identifying information) at the end of a message

**Include a subject line.** Give a descriptive phrase in the subject line of the message header that tells the topic of the message (not just “Hi, there!”).

**Avoid sarcasm.** People who don’t know you may misinterpret its meaning.

**Respect others’ privacy.** Do not quote or forward personal email without the original author’s permission.

**Acknowledge and return messages promptly.**

**Copy with caution.** Don’t copy everyone you know on each message.

**No spam (a.k.a. junk mail).** Don’t contribute to worthless information on the Internet by sending or responding to mass postings of chain letters, rumors, etc.

**Be concise.** Keep messages concise—about one screen, as a rule of thumb.

**Use appropriate language:**

- Avoid coarse, rough, or rude language.
- Observe good grammar and spelling.

**Use appropriate emotions (emotion icons) to help convey meaning.** Use “smiley’s” or punctuation such as :- ) to convey emotions. See website list of emoticons at <http://netlingo.com/smiley.cfm> and <http://www.robelle.com/smugbook/smiley.html>.

**Use appropriate intensifiers to help convey meaning.**

- Avoid “flaming” (online “screaming”) or sentences typed in all caps.
- Use asterisks surrounding words to indicate italics used for emphasis (\*at last\*).
- Use words in brackets, such as (grin), to show a state of mind.
- Use common acronyms (e.g., LOL for “laugh out loud”).

2. “Summing Up”—Ask students to read an article or chapter and then post their brief summary or précis of the key point(s). A limit of 140 characters demands a lot of academic discipline.
3. “Twit Links”—Share a hyperlink—a directed task for students; each is required to regularly share one new hyperlink to a useful site they have found.
4. “Twitter Stalking”—Follow a famous person and document their progress. Better still if this can be linked to an event (during the recent U.S. Presidential elections, many people followed @BarackObama and kept up to date with his speeches, etc.).
5. “Time Tweet”—Choose a famous person from the past and create a Twitter account for them; choose an image that represents the historical figure and over a period of time write regular tweets in the role of that character, in a style and using the vocabulary you think they would have used (e.g., William Shakespeare, Julius Caesar).

6. “Micro Meet”—Hold discussions involving all the subscribing students. As long as everyone is following the whole group, no one should miss out on the Twitter stream. All students participate because a sequence of contributors is agreed on beforehand.
7. “Micro Write”—Progressive collaborative writing on Twitter. Students agree to take turns contributing to an account or “story” over a period of time.
8. “Lingua Tweeta”—Good for modern language learning. Send tweets in foreign languages and ask students to respond in the same language or to translate the tweet into their native language.
9. “Tweming”—Start off a meme (idea); agree on a common hash tag so that all the created content is automatically captured by Twemes or another aggregator.
10. “Twitter Pals”—Encourage students to find a Twitter “penpal” and regularly converse with them over a period of time to find out about their culture, hobbies, friends, family, etc.; ideal for learning about people from other cultures.

(Used by permission of Steve Wheeler.)

**Bulletin boards.** **Bulletin boards (BBs)** are electronic message centers but are used for posting messages of interest to group members who visit the BB, rather than for emailed notices that all members receive at once. Bulletin board members must go to the BB location to review and leave messages. Bulletin board communications are sometimes known as “threaded discussions” and are very common in educational content management systems such as *Blackboard* or *Moodle*.

**Blogs.** Short for web log, a **blog** is a web page that serves as a publicly accessible location for discussing a topic or issue. Blogs began as personal journals, but their use rapidly expanded to a public discussion forum in which anyone could give opinions on the topic. Blogs are interactive websites for discussion, potentially among many people, but are created, designed, managed, and updated by an individual, with regular entries of event descriptions, opinions, narratives, and commentaries added over time. Blog authors can upload images, video, links, and other documents to support their content. Users do not have to understand HTML or other authoring languages to create and update blogs; rather, most blogging sites provide a content management system that consists of easy-to-use forms in which users enter their text, images, and content, with the page immediately published online for anyone to see (e.g., WordPress.com, Blogger.com, MovableType.com).

**Listservs.** These are programs that store and maintain mailing lists. **Listservs**, or lists, make possible ongoing email

“conversations” among groups who belong to an organization or share common interests. When an email message is addressed to a listserv mailing list, it is automatically duplicated and sent to everyone on the list. Replies to a listserv also go to everyone on the list, but only those on the list can send a message.

## Chatrooms, Instant Messaging, Text Messaging, and Videoconferencing

Four kinds of communications can be synchronous. These include:

**Chatrooms.** **Chatrooms** are Internet locations that allow “live” communications between two or more users. As users in a chatroom type in their comments, everyone in the “room” sees what they type.

Users of chatrooms sometimes use **avatars**, moving 3-D figures that represent people in virtual environments. Avatars may or may not actually look like the person they represent. This use is more common in higher education than in K–12 environments. Common areas where chatrooms are used are within educational content management systems, such as *Blackboard* or *Moodle*, and in social networking environments such as Facebook.

**Instant messaging.** One type of Internet communication is **instant messaging (IM)**, a service that allows users to use private chatrooms in which members alert each other when they wish to chat. Members then may send messages that are received immediately—like a telephone conversation but with text messages. The IM system alerts a person when someone wishes to chat with him or her. IMs are usually live, but they also may be left as messages to be read later, and the person notified can then initiate a chat session. IM communications make frequent use of abbreviations, such as RUOK for “Are you okay?” and CUL for “See you later.” Students are natural IMers, and schools are finding ways to make instructional use of this versatile communication tool. Lewis and Fabos (2005) provided a detailed account of student uses of instant messaging and described the changing epistemologies and attendant practices associated with IM use (multivocality, performativity, resourcefulness, hybrid textuality, and new forms of circulation and surveillance). Common IM programs are Apple *iChat* and Yahoo *Messenger*.

**Text messaging.** Like instant messaging, **text messaging** allows for instant communications between people but is done with cell phones, rather than on the Internet, and allows for sending images and short videos, as well as text. Text messaging has become such a primary means of communications that it has overtaken voice communications on cell phones in frequency of use. It has become so frequent, in fact, that people even do it while driving, causing such

problems that some states have already banned the practice. Educators have already begun to explore ways of taking advantage of the popularity of text messaging among young people (Faure & Orthober, 2011).

**Videoconferencing.** This form of two-way interactive communication allows those involved to see and hear each other. Each person must have a camera, an audio input device such as a microphone, and an output device such as speakers. In addition, each participant must use a program such as *Skype* or *iChat*. It is also helpful to have a high-speed connection so the video will move smoothly. Videoconferencing is used more in higher education than in K–12 schools, but it is becoming more common as high-speed connections in schools become more common.

## USING INTERNET FEATURES AND TOOLS: SOCIAL NETWORKING AND COLLABORATIONS

Currently, the most powerful uses of Internet tools are for social networking and collaborating with others in many different locations. Tools that have made these powerful uses possible include: avatar spaces, wikis, podcasts, e-Portfolios, video and photo sharing communities, and social networking communities.

### Avatar Spaces

The future of the Internet will be increasingly visual, and one feature contributing to this is the use of **avatar spaces**. The widespread use of avatars on the Internet was proposed in Neal Stephenson’s 1992 science fiction novel, *Snow Crash*. These figures can be made to look much like the person they represent, or they may be complete fantasy figures, selected by a user to project a certain aura or point of view. The uses of avatar spaces in education are limited but have great potential for fostering visual literacy, motivating students to develop writing and other communication skills, and helping teach skills that involve visual design. The most popular avatar-based environment is *Second Life*<sup>®</sup>, where a virtual world is giving thousands of individuals, literally, a second life. Numerous higher education schools are teaching courses within *Second Life*<sup>®</sup>.

### Wikis

**Wikis** are a collection of web pages located in an online community that encourage collaboration and communication of ideas by having users contribute or modify content, sometimes on a daily basis. Many instructors use wikis both



in their classes for their students to develop their own wikis or they develop wikis to communicate their own content. For example, Beach, Anson, Breuch, and Swiss (2008) used the popular wiki site PbWorks (<http://pbworks.com>) to electronically publish their textbook on blogs, wikis, and digital tools (see Figure 8 and Technology Integration Example 1).

One of the most recent iteration of a wiki, is Qwiki (<http://www.qwiki.com>). Qwiki is an automated information experience, for your browser or iPad, designed to provide a human-like storytelling approach to searching content.

## Podcasts

Digitized audio files often saved in MP3 file format, **podcasts** are created by users and shared over the Internet for playback on the computer or personal media devices (e.g., Apple iPod). What differentiates a podcast from simply uploading an audio file to a website is that podcasts can be syndicated and subscribed to by online users for automatic download. Podcasts typically resemble a radio broadcast or audio interview.

## e-Portfolios

**e-Portfolios** (e.g., ePortfolio.com) are websites created by students to showcase their work and to organize, revise, and store digital assets they have created inside and outside the classroom. The distinction between an e-Portfolio and a

### FIGURE 8 Using Wiki for Publishing a Textbook



Source: <http://digitalwriting.pbworks.com>. *Website for Teaching Writing Using Blogs, Wikis, and Other Digital Tools*, Norwood, MA: Christopher Gordon Publishers. Reprinted by permission.

blog often resides in the cleaner, more organized and professional design of an e-Portfolio, as well as in the nature of the content. Whereas blogs may consist of open-ended opinions and rough narratives or ideas, e-Portfolios typically are comprehensive, organized collections of assets, descriptions, and reflections.

## TECHNOLOGY INTEGRATION EXAMPLE 1

### COLLABORATIVE STORYTELLING USING WIKIS

**TITLE:** Wiki Tales

**CONTENT AREA/TOPIC:** Language arts, literacy

**GRADE LEVELS:** 6–8

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation, Standard 2—Communication and Collaboration, Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: English; Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information; ICT: Apply technology effectively; Social and cross-cultural skills: Work effectively in diverse teams

**DESCRIPTION:** Divide students into groups of two or three. Using wikis (your school may have a wiki engine it uses, or there are free wiki sites available, such as Wikispaces), have each group begin by creating a page and collaboratively writing an introduction to a story. The introduction must include enough unique characters that each group member can focus on at least one. Students should discuss what will happen to these characters and how their stories will diverge and then weave together at the end. Each group member will create individual pages about their chosen character(s) linked to the collaborative group introduction. Encourage students to brainstorm, with their group members, ways they can link back to common pages where their characters interact with each other. Groups can also include images and outside links within their stories that help convey their tale and the personalities of their characters. The project can be extended by having groups try to link their stories to other group's stories within the class and/or by having groups edit each other's work.

**Source:** Based on the lesson *Collaborating, Writing, Linking: Using Wikis to Tell Stories Online* at the *readwritethink* website: <http://www.readwritethink.org>

## Video and Photo-Sharing Communities

Video and photo sharing communities (e.g., YouTube.com, Vimeo.com, Flickr.com) are websites that provide users with easy-to-use tools to upload video and photo files to a server for online sharing, either public or private, with viewers from around the world. Online viewers can comment on the videos and photos, tag (i.e., provide keywords) the content for increased searchability, and rate the quality of content or artistic vision of the user-generated media.

## Social Networking Sites

Although the term Web 2.0, an Internet trend that puts the authorship of online content into the hands of a web-sites' users, has become very common in educational circles, what educators are hearing more about today are discussions around social networking. Social networking sites (e.g., MySpace.com, Facebook.com, Google Plus) focus on building communities of individually designed web pages consisting of personal profiles, blogs, photo slideshows, music and videos, podcasts, and a network of connected friends or supporters. Users can design and upload their content, meet and connect with friends from around the world, and share media and interests in an online, easy-to-use website environment.

Social networking sites (SNSs) today include CyWorld, MySpace, Facebook, and LinkedIn, and Google Plus. The most common social networking site is Facebook, which began in 2004 and has exponentially grown to over 600 million users. According to Lenhart et al. (2010), among adults who have a social networking profile, 73% have a Facebook profile, followed by 47% who have a MySpace profile, and 14% who have a LinkedIn profile. The percentage of college students who use Facebook varies a great deal, according to the source, but averages are between 60% and 100%. Research on social networking sites and education is growing and differs greatly. To date, the majority of research surrounding social networking sites, such as Facebook, in education has focused on privacy concerns and identity presentation (Debatin, Lovejoy, Horn, & Hughes, 2009). Ellison, Steinfield, and Lampe (2007) and Capital, Park, and Kerk (2009) noted that Facebook provided "Social Capital" for college students and supported personal relationships. Qiyun, Woo, Quek, and Yang (2011) discussed the use of Facebook as a learning management system (LMS), noting that it can be used as an LMS, but it does have certain limitations, such as the inability for students to upload certain file formats, the discussions were not organized in a threaded discussion, and students did not feel it was a safe environment. Ultimately, researchers know that

social networking sites are popular, but the jury is still out on the impact and the value of them in education.

## Integration Strategies for Social Networking Tools

As noted above, social networking tools are steadily becoming the most-used authoring technologies in the classroom. Ideas for harnessing the full potential of such technologies are only in their infancy; however, fresh and innovative integration strategies are flourishing throughout Internet education forums and in the pages of recent academic research publications.

Integration strategies are somewhat inherently built into the definitions of each technology and social networking site. For example, whereas blogs encourage students to think critically when composing and sharing reflections on coursework or course topics, wikis encourage students to think collectively about a subject or event and conceptualize where (and how) their personal description or understanding of the concept fits into a larger structure of community-generated knowledge. On the other hand, social networking communities and video/photo sharing communities encourage students to share and reflect upon their work and lives in the context of a broad community of connected individuals. (E-portfolios accomplish a similar task in the classroom, simply through a more organized and professional medium.)

There are numerous strategies for integration wikis within the classroom. For example, Duffy (2008) noted that wikis can be used to document research projects; build collaborative bibliographies; design online courses by using the wiki as a content management system; provide a reflective tool for teachers and students in any learning experience; and supplant traditional presentation software such as PowerPoint.

## WEB COURSE DEVELOPMENT AND SUPPORT

Web-based courses and degree programs are becoming increasingly common in K–12 education. More and more teachers are participating in the design and delivery of these activities. Various tools and information can be useful when designing course and online instruction. Developing and hosting web courses require an array of online and offline tools. Distance courses are made possible by a **course management system (CMS)**, an online collection of web

course design and delivery tools. This section will review current course management systems, as well as characteristics of effective courses and strategies for assessing their quality.

## Course Management Systems and Other Course Tools

Since around 1997, course management systems (CMSs) have become the most common means of designing and delivering web-based courses. A school or district usually buys a license for a system, such as *Blackboard* or *Desire2Learn* (D2), and its personnel use the system's features (e.g., graphics, conferences, chatrooms, email, links to PDFs and web pages) to design and deliver courses hosted by its servers. The course management system also includes gradekeeping and student tracking features, such as an electronic portfolio for each student. More recently, **open-source software** (software that is freely distributed) CMSs have become available and are becoming extremely popular. Software programs such as *Joomla* and *Moodle* are changing the landscape of CMS use for distance learning development.

Other tools are available to supplement CMS uses. These include video environments, such as *Go To Meeting* (<http://www.gotomeeting.com>) and *Elluminate Live* (<http://www.elluminate.com>), tools that allow groups of individuals to hear and see each other, as well as exchange information such as *PowerPoint* presentations. There are also numerous open-source tools for distance teaching and learning you can view in the Open-Source Options feature for this chapter.

## Characteristics of Effective and Well-Designed Distance Courses and Programs

Even in today's electronic world, the understanding of what makes a quality online course is still somewhat misunderstood. Some believe that a distance course is simply putting course content online, while others are experimenting with what best engages learners and leads to the greatest learner outcomes. Henry and Meadows (2009) identified nine principles for excellence in web-based teaching:

- » **The online world is a medium unto itself**—Developing courses for distance delivery is extremely different than developing a face-to-face class in numerous ways. For example, instructors need to remember that students do not have a classmate sitting next to them to provide clarification; they also need to read directions carefully rather than hearing them from the instructor. Thus, one must understand that the approach to distance courses is completely separate, and that every step of placing content online and using the correct pedagogy needs rethinking.
- » **In the online world, content must engage**—Rather than simply presenting content to the learner, online content must purposefully and strategically engage the learner.
- » **Technology is a vehicle, not a destination**—With the many modes of technology at our fingertips (wikis, blogs, podcasts) we have to remember that just asking

## Free open source **OPTIONS** for Distance Teaching and Learning

### INSTRUCTIONAL OPTIONS

#### Content management systems

*Drupal*: <http://drupal.org>

*Moodle*: <http://moodle.org>

*Open-Source CMS*: <http://php.opensourcecms.com>

#### Avatar spaces

*SecondLife*: <http://secondlife.com>

*Kino*: <http://www.osalt.com/kino>

#### Wikis

*MediaWiki*: <http://www.mediawiki.org>

*Mindtouch*: <http://www.mindtouch.com>

students to use more technology does not mean their learning or engagement will increase.

- » **Great online courses are defined by teaching, not technology**—Many people think that the answer is technology; however, still today, the quality of online courses is based on the pedagogical strategies, not the technology.
- » **Sense of community and social presence are essential to online excellence**—Building community and developing social presence is needed for students to be engaged and reduce attrition. Simply noted, students cannot feel as if they are alone in an online course. Thus, through interactive activities and instructor and student presence through photos and videos, students need to feel they are not on an island.
- » **Excellence requires multiple areas of expertise**—Instructors that are new to designing and developing online courses need to understand the depth of knowledge that is needed to teach online. This knowledge ranges from the uses of technology to pedagogical strategies.
- » **A great web interface will not save a poor course, but a poor web interface will destroy a potentially great course**—Students are alone in an online course; thus, the instructor needs to anticipate what may go wrong for the student and how these issues can be mitigated.
- » **Excellence comes from ongoing assessment and refinement**—Just like any good face-to-face course, distance courses need to go through constant iterations of assessment and refinement.
- » **Sometimes the little extras go a long way**—Anytime an instructor can provide a little extra to help the students understand their tasks, it should be provided. This may range from examples of exemplary assignments to brief audio or video clips that describe expectations and assignments.

Effective online courses have been offered in every content area from math to music, and from physics to physical education. A review of these courses yields the following four common, essential characteristics: effective course structure and design, engaging learning activities, interactive learning communities, and effective assessment strategies.

#### **Well-designed and structured to support learning.**

Just as with any course, effective online courses must be well planned and systematically designed to take advantage of the unique capabilities and constraints of the learning environment.

**Engaging, collaborative activities.** Although some students prefer courses to be individual, tutorial-like ones in which they work at their own pace through a sequence of tasks, the most enjoyable courses seem to be those in which students are highly engaged in discussion and collaboration. Many online courses encourage this kind of engagement through the bulletin boards or other forms of online discussions.

Chen, Wang, & Hung (2009) identified 14 online discussion rules:

- » Defined time boundaries (start and end dates)
- » Setting a minimal number of posts
- » Removing a minimal number of posts
- » Evidence-based argumentation
- » Aligned goals (aligning discussion goal with course assignment)
- » Interdependent collaborations
- » Informality (informal tones)
- » One point per short message
- » Meaningful topic descriptors
- » Invitation to respond
- » Delayed start (provide opportunities for lurking before class)
- » Reference to others (build community by commenting on others' ideas)
- » Compulsory response to responses
- » Offering summaries (providing proper closure)

**An interactive learning community.** Teachers and students agree that online courses are more motivating if they simulate the **learning community** one finds in a good face-to-face course. Sadera, Robertson, Song, and Midon (2009) noted that students' overall sense of learning community is one of the most important factors in student learning. However, it is apparent that learning communities require more than just well-designed instruction, and further research is needed as to how community relates to online learning. Learning communities also involve strategic, ongoing efforts by the instructor to encourage student-to-student interaction, as well as student-to-instructor interaction, and to have students get to know each other as learners and as people. They are communities in the truest, most culture-based sense of the word.

#### **Effective assessment strategies for online courses and programs.**

While alternative assessments are popular in online lessons, many online learning course systems also offer traditional assessment options. *Blackboard*, for example, has a test module with which instructors can develop

objective tests, have students take them online, grade them automatically, and summarize test results across the class.

## Assessing the Quality of Distance Courses

O’Neil and Fisher (2009) noted that online learning is drastically different than learning face-to-face, and thus, assessing learners at every stage of their experience is vital. The learner’s skills, abilities, and orientation within the class need to be assessed, and the learner should be given feedback through the entire course. They noted numerous suggestions for formative evaluation during an online course:

- » “Pulse Check:” asking students at least every four weeks to note their “pulse” within the course, that is, how they feel they are doing, stresses, and how improvements could be made
- » Discussion summaries every other week about the course content and issues
- » Mid-semester survey
- » Verbal feedback to specific questions

Miller, Doering, and Scharber (2010) discussed the importance of assessment and feedback in online courses and identified four common threads that should be considered when design and implementing an online environment. These include: “(1) type and communication, (2) theoretical grounding, (3) alignment with goals and the nature of the task, and (4) scaffolding through sense-making tools” (p. 87).

- » **Type and communication**—Teachers should think beyond traditional objective scoring when giving feedback to their students and should be “evolving communication between teachers and students (i.e., a feedback package or portfolio), as opposed to a disparate instance of notification. Additionally, feedback does not necessarily end with the student audience; designers should explore options to include teachers, parents, and other parties of interest in the use and communication of feedback” (p. 87).
- » **Theoretically grounded**—Assessment and evaluation should match the theoretical foundation in the way we teach. Thus, instructors should “focus on creating opportunities for evolving support, feedback, and assessment, not simply the delivery of content” (p. 88).
- » **Aligned with the goals and nature of the task**—Whenever possible, instructors “should align feedback

with goal setting through clear descriptions of student goals and expectations. Additionally, the nature of feedback should align with the nature of the assessment task” (p. 88). Thus, instructors must make sure that students are assessed in the same way that we are asking them to perform their assignments. For example, if we are asking them to perform a spatial activity on a map, we should not assess them with a multiple-choice test but with a task where they are using their spatial skills.

- » **Scaffolded through sense-making tools**—Assessment and evaluation should involve tools that assist the learner in understanding what their scores mean. This may include the use of graphs or other information visualization tools.

There are also specific rubrics and checklists to assess the quality of distance courses. Roblyer, one of the authors of this text, developed a post-course evaluation instrument (*Rubric for Assessing Interactive Quality of Distance Courses*) that focuses on the following characteristics (Roblyer & Wiencke, 2004):

- » Social/rapport-building designs for interaction
- » Instructional designs for interaction
- » Interactivity of instructional resources
- » Evidence of learner engagement
- » Evidence of instructor engagement

There is also the Quality Matters program (see <http://www.qmprogram.org>), which is a faculty-centered, peer review process designed to certify the quality of distance learning courses. Quality Matters has developed a set of forty elements that are distributed across eight broad standards. It is these elements that are used to evaluate the design of online and hybrid courses. The eight broad standards on which the elements are based include:

1. Course Overview and Introduction
2. Learning Objectives
3. Assessment and Measurement
4. Resources and Materials
5. Learner Engagement
6. Course Technology
7. Learner Support
8. Accessibility

Finally, *The Rubric for Online Instruction* (see <http://www.csuchico.edu/celt/roi>), designed and hosted online by

California State University–Chico, focuses on the following characteristics:

- » Learner Support and Resource
- » Instructional Design and Delivery
- » Innovative Teaching with Technology
- » Online Organization and Design
- » Assessment and Evaluation of Student Learning
- » Faculty Use of Student Feedback

## APPLYING APPS IN EDUCATION

Educational apps for mobile devices such as smart phones (e.g., iPhone, Android, BlackBerry) and digital tablets (e.g., iPad, Slate, Galaxy Tab, Xoom) represent an extraordinary and largely untapped array of tools for educators and their students to build the skills, knowledge, and expertise needed for work and life in the 21st century. **App** is an abbreviation for application, and normally has an extension of .app on the file. The term usually refers to any Internet application specifically designed to run on mobile devices such as smartphones. Apps are designed exclusively for the platform they will be operating on. For example, if you are hoping to find an app for your iPad, you would search for iPad apps or **universal apps**, those that work on all platforms: the iPad, iPod, and iPhone.

“There’s an app for that” has quickly become the tech catchphrase of the current decade for small applications that run on mobile devices. The mobile apps revolution is sweeping the nation and indeed the world, in concert with the availability and capabilities of smart phones and tablet devices. With more than 20 million Apple iPads and in excess of 100 million iPhone and iPod Touch devices in use, Bradshaw (2011) says that many universities, K–12 schools, and institutions are selecting the iPad and iPod Touch as the platforms of choice for face-to-face and distance education classrooms.

### Locating, Downloading, and Integrating Apps

Locating, downloading, and integrating apps for educational purposes can, at times, be a challenging task. Trying to find the perfect app that provides the content, collaboration, and/or interaction that an educator is looking for to augment a curricular unit could take hours of searching for the app and hours learning how to use the app within their classroom.

**Locating Apps.** As of the writing of this text, Apple’s iTunes Store hosts over 425,000 apps, with over 14 billion downloads, and the prediction is that the Android app market will have even more apps than the Apple’s iTunes App Store by mid-2012 (Lookout Mobile Security, 2011). With these large numbers in mind, how does an educator find that perfect app? Apple users (iPhone, iPod, iPad) simply go to Apple’s iTunes App Store, where they can use keywords to search for the perfect app, search by genre, or see what the top paid and free apps are for the day. Or, if the user chooses, they can locate the app in the iTunes Store on the mobile device. Though many apps are free, others are usually \$3 to \$5. Apple does provide what is known as the “App Store Volume Purchase Program” where an educational institution can buy “Volume Vouchers,” and apps can be purchased in volume and distributed to multiple devices. Therefore, a social studies teacher interested in teaching world history could type in the keywords “world history” and find an app that may be of interest. Android users also have numerous places to download Android apps, including the Android Market, located at <https://market.android.com>.

Fortunately, those who wish that someone else would do the filtering work of all the apps available can visit the many educational sites that research and rate the best apps for the educational market such as “Apps in Education” (<http://www.appsineducation.com>).

**Downloading Apps.** The downloading of the apps to the mobile device has been streamlined over the past years with the ability to download apps from a computer or the mobile device itself. Those users running Android can download apps via the Android Market website, the Android Market app on their mobile device, or from third-party sources. Those users using an Apple device can download apps from Apple’s App Store within iTunes or also from the App Store app on the mobile device. With both platforms, apps are automatically installed and the user is notified when any updates to the app become available.

**Integrating Apps.** A hot topic right now is how educators can use mobile devices and apps within their classroom. Much like educational technologies in the past, educators are exploring how to use these apps in their classroom, how to rate the variety of apps that are available, and the impact of these apps on learning. In fact, many universities are purchasing iPads for their students, betting that their return on their investment will be seen through student learning and engagement. For example, in the College of Education and Human Development at the University of Minnesota, all 2010 incoming freshman students have been provided free iPads (Ross, 2010). The jury is still out how this will impact learning.



# SUMMARY

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

## 1. An Evolving Use of the Internet: Distance Education

- » Distance learning delivery systems may be classified from most abstract to most realistic, according to types of interaction (from one-way, print-based to two-way video) and delivery methods (from correspondence courses to videoconferencing).
- » Types of distance learning activities include student research, online materials, web-based lessons, and virtual courses and programs.
- » Current distance learning issues include the widening Digital Divide, concerns about children's development and socialization, impact on school reform, and virtual schooling issues.
- » Current research and status of distance learning include the effectiveness of learning online versus face-to-face, course characteristics that affect success, virtual schooling research, characteristics of successful distance learners and instructors, and the cost-effectiveness of distance learning.

## 2. The Internet

- » The U.S. Department of Defense (DOD) developed the first version of the Internet during the 1970s to allow quick communication among researchers working on DOD projects in about 30 locations.
- » As the Internet has become a society-wide tool, the Internet has also spawned its share of society-wide debates, problems, and controversies. In many ways, it is a reflection of the best and worst qualities of our society. Problems with equity and human behavior (and misbehavior) have already begun to emerge. Although there are numerous issues, five potential problem areas are discussed here, along with strategies that educators can use to make the Internet a safer, more worry-free place for teaching and learning.

## 3. Using the Internet Features and Tools: Navigation

- » Students and teachers who use the Internet should know how to use URLs, strategies for navigating sites, and how to use the Bookmarks or Favorites files.

## 4. Using the Internet Features and Tools: Searching and Storing

- » Students and teachers who use the Internet should know different types of search engines, how to use search engines, and the concept and utilization of cloud computing.

## 5. Using the Internet Features and Tools: Communicating

- » Online communication resources include tweeting, email, listservs, bulletin boards, blogs, chatrooms, instant messaging, and videoconferencing.

## 6. Using the Internet Features and Tools: Social Networking and Collaborations

- » Collaborative spaces include many opportunities for students to share, discuss, and interact with each other online, and includes wikis, avatar spaces, podcasts, e-portfolios, video and photo sharing communities, and social networking sites.
- » Integration strategies that make use of these technologies are flourishing.

## 7. Web Course Development and Support

- » Course management systems and other course tools need to be understood so distance education courses can be effectively designed, developed, and utilized.
- » Characteristics of effective and well-designed courses include engaging and collaborative activities, an interactive learning community, and the use of effective assessment strategies.
- » Assessing the quality of distance courses includes understanding how the course is theoretically grounded; how the goals and nature of the tasks are aligned; and how tools can be used to scaffold learners. Distance course quality may be assessed during design using the *Rubric for Online Instruction*, and after completion of a course using the *Rubric for Assessing Interactive Qualities of Distance Courses*.

## 8. Applying Apps in Education

- » To use apps in education, teachers need to know how to locate, download, and integrate apps for mobile devices.



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** In Aoun's (2011) article, "Learning today: The lasting value of place," he notes that "Bill Gates predicts...place-based activity in college will be five times less important than it is today, due to the ever-growing popularity of online learning." Gates said, "Five years from now, on the Web—for free—you'll be able to find the best lectures in the world. It will be better than any single university...College, except for the parties, needs to be less place-based." Make a table of the pros and cons of learning at a distance versus learning in a physical location. Analyze your table in order to address the question, "Is Bill Gates' prediction correct?" Is the answer different for K-12 students than it is for college students?

**2.** Facebook has had a tremendous impact on the everyday life of people in our society. In 2011, Facebook opened up development of downloadable applications, which may further supplement the educational functions of Facebook. With startling statistics on Facebook use by students of all ages, and the quality design of the environment, the potential positive impact of this tool in education is still in question. Is there a role for Facebook in education? If so, how would you articulate that role?



# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your **Technology Integration Lesson Planning** exercises
- » Artifact you create from one of the Project Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- a. Describe the Phase I—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- b. Describe the Phase II—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- c. Describe the Phase III—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario, focusing on Tech-PACK situations, and analyze it by answering the questions.

*Ms. Clausen is a twelfth grade history teacher who has always enjoyed teaching about the Civil War. From her high school days when she first learned about the Civil War, to her college days of learning the pedagogy of how she might introduce the topic to her students, she has always appreciated putting students into as much of an authentic context as possible when learning history. For example, she always asked her students to dress up and take on certain roles during her first five years of teaching. Now, she would like to take this role playing one step further as she heard about the many opportunities of using SecondLife within education. In fact, she recently learned she could have her students be avatars in SecondLife, and they could go to the Civil War area of the environment and take on authentic roles as they learn the history of this important event. Ms. Clausen knows her content very well and she believes she is a great teacher without technology; but she wants to learn*

the technology, introduce it to her students, and see what added value this technology may have in her classroom. The great thing is that she has access to a new computer lab that has enough laptops for all of her students!

- a. Deconstruct Ms. Clausen’s Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological,

pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



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.

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# DEVELOPING AND USING WEB-BASED LEARNING ACTIVITIES

# DEVELOPING AND USING WEB-BASED LEARNING ACTIVITIES

The internet has helped shift written communication from a private space to a public one...we're experiencing the benefits of being encouraged to develop ideas and arguments in public. Shifting writing from private to public spaces, in the long run, will be beneficial for the spread of human knowledge.

Ethan Zuckerman, "Global Voices," from *Future of the Internet IV*, Pew Internet & American Life Project

## o u t c o m e s

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

1. Examine, communicate, create, and assess the variety of web-based activities that are available to integrate with the classroom.
2. Develop and assess instructional activities that utilize a framework for web-based activities.
3. Develop and integrate web-based programs and lessons.



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## key terms

ActionScript  
ASP.NET  
domain name  
design  
downloaded

electronic field trip  
electronic mentoring  
electronic publishing  
File Transfer Protocol (FTP)  
Flash

GIF (format)  
Google Docs  
group product development  
HTML  
HTML 5



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## TECHNOLOGY INTEGRATION IN ACTION: AGAYU: ADVENTURE LEARNING IN CHUKOTKA, RUSSIA

GRADE LEVEL: Elementary and middle school • CONTENT AREA/TOPIC: Social studies, science, language arts, oral traditions • LENGTH OF TIME: One week

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage

Ms. Anderson was upset at how her students were reacting to the activities she taught in her geography course. She was using a recent geography textbook and many accompanying activities, but still her students were not motivated. A colleague of Ms. Anderson's, Mr. Clay, was using a hybrid online adventure learning program entitled *GoNorth!* in which his students were studying social studies while following a group of scientists, explorers, and educators as they dogsled across the Arctic, and using an online K-12 curriculum, interacting and collaborating with literally millions of students worldwide. Mr. Clay's students had covered the walls in the school with pictures they made that represent the Polar Huskies, dogsleds, and activities from the online learning environment. In fact, Ms. Anderson's students were always hearing about the program from Mr. Clay's students during lunch, and they asked if they could get

involved with the program, too. She decided she would take a closer look at the online environment to see what the real



Source: Courtesy of *GoNorth!* Adventure Learning Series  
<http://www.polarhusky.com>. Reprinted by permission.

image formats  
Java  
Java applets  
Javascript  
JPEG (format)

MUD  
PHP  
plug-ins  
Portable Document Format (PDF)  
problem-based learning (PBL)

site map  
social action projects  
storyboard  
streamed video and audio  
VRML

web-based learning  
web-based lessons  
web-based programs  
webquest  
wireframing



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advantage of the program would be. She went to the *GoNorth!* website (<http://www.polarhusky.com/2007>), obtained her username and password, and logged in. The program was free, so she decided she would definitely check out the curriculum and the online activities. Ms. Anderson soon came to realize that her students could learn about the science and geography of numerous places around the world as if she and her students were actually there. In addition to the authentic nature of the activities, her students could collaborate with other students worldwide, interact with the online games, send a note to the team in the Arctic, and truly become part of the experience. She also realized by watching Mr. Clay's students that her students would probably be motivated to learn. Ms. Anderson checked out the curriculum online and decided to start with the Agayu lesson of Module 2.

## Step 2: Assess Tech-PACK.

**Technology and Pedagogical Domains.** Before immediately jumping into the project, Ms. Anderson assessed her technological, pedagogical, and content knowledge to see where she might be deficient and also where she could capitalize on her strengths. She realized her technological and pedagogical knowledge were very strong compared to her content knowledge. She had been selected as a "Technology Teacher Mentor" within her school and felt very comfortable assisting her fellow colleagues with numerous technologies and how they can be integrated within the classroom. It seemed that she was always the teacher that people were calling on for help. From creating podcasts to having students design, develop, and publish their own YouTube videos, Ms. Anderson was a technology guru!

**Content Domain.** Although her content knowledge was not as strong, Ms. Anderson noted the comprehensive curriculum that was part of the *GoNorth!* project. She reviewed it and saw that the content that is being taught in each module is specified clearly. Thus, she decided to go ahead and move forward with integrating Agayu within her classroom.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Ms. Anderson wanted her students to feel more motivated to study social studies, but she also wanted to make sure they were reaching the necessary goals of the established school curriculum. To make sure they achieved the goals, she wrote down the outcomes and objectives, and designed assessments matched to each one, as follows:

- » **Outcome:** The understanding and appreciation of culture.  
**Objective:** Students will achieve a 90% rubric score to show they can describe how culture is experienced through language and how the people with whom Team *GoNorth!* interact are the same and different from themselves. Students will work cooperatively to complete the *GoNorth!* Agayu lesson on storytelling, reading traditional stories from the Yu'pik people of Chukotka, Russia. **Assessment:** Rubric covering completion of required tasks, search strategies, locating required information, cooperative group work, and discussion.
- » **Outcome:** Improved attitudes about studying geography and cultures around the world. **Objective:** Students will demonstrate increased motivation to learn geography by scoring at least 25% higher on a geography attitude survey after the instruction compared with before. **Assessment:** Likert scale attitude instrument.

### Step 4: Design integration strategies.

Ms. Anderson felt it would be best if the students did some exploratory research at the beginning of the activity by spending time within the *GoNorth!* online learning environment, and then following up the exploration with the activity written within the *GoNorth!* curriculum, as it effectively integrated the Internet within the curriculum.

- » **Day 1: Introduce the project and the website; give the pre-instruction attitude survey.** Using the classroom computer with an electronic whiteboard, show the *GoNorth!* website and the many areas students can explore to become part of the project. These areas include web pages, such as the Yaranga, Polar Husky A-to-Z, collaboration zones, expert chats, the online game Wumpa's World, and the Polar Husky dogyard.
- » **Day 2: Brainstorm as a class to create a concept map about what an oral tradition is.** Share with the students that Native Arctic cultures, such as the Yu'pik and the Chukchi people in Chukotka, have been preserving their history and culture through various oral traditions, and that written accounts are only very recent (beginning in the 1960s). Explain as well that oral tradition includes storytelling in many formats. After the discussion and brainstorming, watch "The

Drums of Winter,” available in Classroom Movies for Module 2 in Scrapbook of the Explore section at <http://www.PolarHusky.com/2007>. Share with students that this was filmed in Alaska on the coast of the Bering Strait, but that the Yu’pik population extends to both sides of the Bering Strait, from Chukotka to Alaska. Discuss the role of drum dancing in the Yu’pik culture. How is this a form of storytelling? Who would be considered the storyteller?

» **Day 3: Pass out the student page titled “Being Fox.”** In pairs or individually, students first read about the fox mask, then read the story associated with the fox mask as told by Yu’pik Elder Alma Keyes, read about the animal itself, and answer the two associated questions. Yu’piks believe that each animal has a special person within. How does this story illustrate that belief? How does the story of the fox mask represent Yu’pik culture?

» **Day 4: In teams of two or more, students read a traditional Yu’pik story assigned from the list below.** The stories can be accessed from Your Study Resources for Module 2 in the Investigate section of Logistics at <http://www.PolarHusky.com> under the title “Yu’pik Stories & Masks.”

- Snowy owl story
- Plant masks story
- Red fox mask story
- Beetle mask story
- Caribou mask story
- Simple mask story
- Salmon berry mask story
- Death mask story
- Half-face mask story
- Clam mask story
- Common loon mask story
- Crow mask (I) story
- Crow mask (II) story

From the assigned story, students develop a mask or several masks for all team members. A mask can be as simple or elaborate as they wish to make it. Students then dance or act out the story. Depending on students’ preference, one student can read the story aloud while others illustrate it. If possible, film or document the students’ enactments in pictures or even in audio. End each performance by talking as a class about the message of the story and its delivery.

» **Day 5: Have students go to Collaboration Zone 02:** Go to Culture Zone to upload pictures of their masks or the video of their mask presentations. Make sure the word “masks” is included as part of the title. While there, have students explore posts from other students and communicate their responses.

### Step 5: Prepare instructional environment.

Ms. Anderson spent time exploring the online learning environment, preparing herself on how to effectively integrate the Internet within her classroom. Preparation tasks included the following:

» **Understanding of website content in general:** Ms. Anderson spent a few hours on the *GoNorth!* website to read the curriculum and activity guide so as to obtain a full understanding of the online learning environment and curriculum.

» **Research lesson and activities:** Ms. Anderson acquired the Agayu lesson from the online curriculum and downloaded the activities and handouts that complemented the online learning environment.

» **Collaboration zones:** Ms. Anderson spent time exploring the collaboration zones, reading what other students and teachers had posted in the past, and getting ready to scaffold her students’ participation within the zones.

» **Computer lab scheduling:** Ms. Anderson scheduled time for her students in the lab so that they could complete the online activities. She also allowed them to do some of the work at home, if they liked.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

After students had completed their masks and uploaded them to the collaboration zones, Ms. Anderson reviewed and analyzed the data from the activities. As she had hoped, she found attitudes toward studying social studies were much improved after the project. Many students made unsolicited comments, such as “Why can’t we learn everything this way?” and “I love Polar Husky!” Her rubrics revealed considerable variation in the understanding of culture. She decided she would continue using the *GoNorth!* learning environment with her students. As a result of implementing *GoNorth!*, exam scores were much improved over what she had seen in the past. Students told her that both the online activities and the making of the masks helped a great deal. It was evident that students who had home computers knew much more about the online learning environment and the *GoNorth!* Team and Polar Huskies than students who had access only at school. She decided to research ways she could give all students more Internet access at school.

### Step 7: Make revisions.

Although the integration of the unit was very successful, Ms. Anderson still wanted to make improvements to the instructional environment. She realized that she would have liked to have more time to learn about the content before she taught it in class. She also wanted more time for her students in the lab so they could utilize the collaboration zones in more depth. The overall pedagogical strategies were quite successful and she wanted to try dividing students into mixed groups based on the students’ technology knowledge. Her hope was that the more advanced students could mentor the novice students.

**Source:** Based on Agayu at <http://www.polarhusky.com/2007>.



## INTRODUCTION TO WEB-BASED LEARNING ACTIVITIES: FROM LESSONS TO ONLINE COURSES

**Web-based learning** has changed greatly over the past decades. Where teachers used to focus on integrating one online activity in the classroom, today we have numerous web-based lessons, projects, and complete courses that teachers are developing and/or finding and integrating within their classroom.

### Confirming Relative Advantage of Web-Based Activities

Web-based activities have great potential to enhance learning, but they are often time-consuming to develop and implement, and difficult to design in ways that have substantial, positive impacts on students' learning (Chen, Lambert, & Guidry, 2010; Coulter, Feldman, & Konold, 2000; Hannafin & Hannafin, 2010). Coulter et al. encourage teachers considering web-based activities to ask themselves several questions before deciding to do an online project. Teachers may use these questions to confirm the relative advantage of online activities in comparison with other strategies they could use to accomplish the same purposes. The following questions are based on those outlined by Coulter et al. (2000) and can form the basis of an integration plan for any type of web-based learning activities:

- » What is the curriculum-related purpose of the activity? Using the Internet should not be thought of as an end in itself; the activity should accomplish some objective or purpose in the required school curriculum.
- » Does the Internet enhance the activity? The rule of thumb is that if the activity could be done well without the Internet, it probably should be.
- » How will students use online resources (as opposed to just locating them)? The object of the activity should be for students to do something with what they locate on the Internet. Once they locate information, they should be asked to determine its meaning, compile and synthesize various sources, or critique its usefulness.
- » Do students have the necessary information analysis/information synthesis skills, or am I including these in the instruction? To make sure the project doesn't become an "information locating" exercise, it should call for additional, higher-level tasks after the students find the information. However, teachers must be sure their students have the prerequisite skills to do these higher-level tasks.

- » Do I have the necessary time and support for the activity? Make sure it is understood that online activities normally take much longer than first thought. Teachers many times do not allow sufficient time for students to complete activities—both in terms of support needed for students to be successful with the activity and the actual time students will be working with the project. Teachers must make sure they have the technical support to resolve these problems in an efficient way so as not to slow down the momentum of the project.

### A Framework for Web-Based Activities

Doering, Hughes, and Scharber (2007) provided a framework consisting of four types of web-based learning activities that show how teachers may employ online resources. The four types are:

1. Individual lesson plans. The majority of online educational resources are individual lesson plans that teachers download and integrate within their classroom, often without adaptation.
2. Online lesson enhancements. The most popular approach to using web-based learning activities is through what Doering, Hughes, and Scharber called lesson enhancements. Lesson enhancements are when teachers identify an online enhancement that augments their curricular goals and use it to extend and deepen their students' understanding. An example of an online lesson enhancement is when a teacher wishes to teach frog dissection and uses an online simulation, the teacher also uses a social networking tool such as a wiki, blog, or discussion board to promote collaboration. Another example is when, during a lesson on plate tectonics, teachers have students use *Google Earth* to note the number, location, and magnitude of earthquakes around the world in the past 24 hours (<http://earth.google.com>).
3. Completely online courses and curriculum. Allen and Seamen (2009) noted in their recent survey that 70% of responding school districts offered completely online courses. These courses range from those that are designed and developed from major online institutions, such as the Florida Virtual School (<http://www.flvs.net>), to individual courses delivered in your traditional brick and mortar schools. These courses provide opportunities to students by allowing them to enroll in subjects that are not available in their face-to-face traditional school, or enroll completely in an online degree-granting institution.

4. All-inclusive online courses, curriculum, and online learning environment. There are also online learning environments that provide all of the earlier noted features—online curriculum, enhancements, courses, and learning environments. Numerous sites today are developed to give teachers the flexibility of choosing and adapting the resources as needed. Thus, if they wish to teach an entire course with the learning environment, they are able to accomplish this. If, however, they wish to use an online simulation to augment and enhance their existing curricula, they are also able to accomplish this. An example of this type of learning environment is The JASON Project (<http://www.jason.org>).

**Electronic Penpals or “Keypals.”** Teachers link up each student with a partner or penpal in a distant location to whom the student writes letters or diary-type entries. Recently, teachers have attempted to do this with social networking sites such as Facebook. However, just like any online environment, there can be risks associated with such an approach. One risk is cyberbullying, which is the Hot Topic Debate feature for this chapter.

**Electronic Mentoring.** Doering, Scharber, Riedel, and Miller (2010) and Doering and Veletsianos (2008) note the importance of subject matter experts when designing online activities. Guidance may be one-to-one links between students and expert resources or may take the form of chats, discussion groups, collaboration zones, or learning communities.

## Types and Examples of Web-Based Lessons and Projects

As with any technology, it is important to note that although the design and content of the online resource delineates a planned implementation, it is still up to the teacher to choose the most appropriate pedagogy for the situation. Thus, although an online course may be developed to be taught throughout an entire semester, a teacher may choose to integrate a single activity to assist in meeting their curricular goals. Ultimately, one of the most exciting distance learning applications calls for students to use technology as a means of collaboration so they can address significant problems or issues or communicate with people in other cultures throughout the world. In recent years, the depth and breadth of collaboration have dramatically improved (Veletsianos & Doering, 2010). In her website Virtual Architecture, Harris (see <http://virtual-architecture.wm.edu>) refers to these efforts as “telecollaborations” and describes three general application categories:

1. **Interpersonal exchanges**—Students communicating via technology with other students or with teachers/experts
2. **Information collection and analysis**—Using information collections that provide data and information on request
3. **Problem solving**—Student-oriented and cooperative problem-solving projects

Harris lists strategies she calls activity structures that fall under these three categories. Lessons based on a given activity structure all follow the same basic design, even though their content and objectives may vary. Detailed descriptions of these activity structures may be found at the Virtual Architecture website. Some forms these models can take are described here, and examples of each are given in Table 1.

**Electronic (or virtual) field trips.** An **electronic field trip** in its simplest form fills classroom screens with visual images of a place considered to offer some educational value and to which students would not routinely be able to travel. Real field trips present a variety of logistical problems, including expense. Electronic field trips are a way to circumvent these problems and bring real-world situations into the classroom. These activities explore unique locations around the world, and by involving learners at those sites, students share the experience with other learners at remote locations. Stoddard (2009) provided a conceptual model for successful virtual field trips and noted that virtual field trips allow student learning to be more authentic and that there is a need for teachers to receive professional development in this area. See the Tramline website for sample virtual field trips and resources to support teacher-designed field trips (<http://www.tramline.com/trips.htm>).

**Electronic publishing.** When students submit their written or artistic products to a website, it is called **electronic publishing**. This allows their work to be shared with other students and visitors to the site and can be done quite easily with products such as **Google Docs** (<http://docs.google.com>). While it used to be uncommon for students to publish online, it is now becoming the norm.

**Group product development.** Teachers have developed many variations of online group development of products. For example, students write papers, develop concept maps, and develop presentations collaboratively online using tools such as *Google Docs* and *C-Map* (<http://cmap.ihmc.us>). Students can literally see each other typing on the same online documents while sitting in different places around the world. Another approach is to have students work independently toward an agreed-on goal, with each student or group adding a portion of the final product. This is sometimes called chain writing.

**TABLE 1** Types and Examples of Web-Based Lessons and Projects

Type of Web-Based Activity	Sample Sites	Description
Electronic pen pals (keypals)	<ul style="list-style-type: none"> <li>ePals <a href="http://www.epals.com">http://www.epals.com</a></li> <li><i>OneWorld Classrooms</i> <a href="http://http://www.ccproject.org">http://http://www.ccproject.org</a></li> </ul>	Links students at a distance to exchange information
Electronic mentoring	<ul style="list-style-type: none"> <li>International telementor program <a href="http://www.telementor.org">http://www.telementor.org</a></li> <li><i>Ask-A-Geologist</i> <a href="http://walrus.wr.usgs.gov/ask-a-geologist">http://walrus.wr.usgs.gov/ask-a-geologist</a></li> <li><i>MadSci</i> network <a href="http://www.madsci.org">http://www.madsci.org</a></li> <li><i>Writing with Writers</i> <a href="http://teacher.scholastic.com/writewit/index.htm">http://teacher.scholastic.com/writewit/index.htm</a></li> </ul>	Links students with experts to answer questions and support learning
Electronic (virtual) field trips	<ul style="list-style-type: none"> <li><i>Tramline</i> virtual field trips <a href="http://www.tramline.com">http://www.tramline.com</a></li> <li>National Health Museum <a href="http://www.accessexcellence.org/RC/virtual.html">http://www.accessexcellence.org/RC/virtual.html</a></li> <li><i>GoNorth!</i> <a href="http://www.polarhusky.com">http://www.polarhusky.com</a></li> </ul>	Visit sites to view people, places, and resources not locally available
Electronic publishing	<ul style="list-style-type: none"> <li><i>Headliners</i> <a href="http://www.headliners.org">http://www.headliners.org</a></li> <li><i>Thinkquest</i> <a href="http://www.thinkquest.org/en/projects/index.html">http://www.thinkquest.org/en/projects/index.html</a></li> <li><i>Midlink</i> magazine <a href="http://www.ncsu.edu/midlink">http://www.ncsu.edu/midlink</a></li> <li><i>VoiceThread</i> <a href="http://voicethread.com">http://voicethread.com</a></li> </ul>	Share written and artistic products on websites
Group product development	<ul style="list-style-type: none"> <li>CIESE online classroom projects <a href="http://www.ciese.org/collabprojs.html">http://www.ciese.org/collabprojs.html</a></li> </ul>	Work on written or artistic products with students at different sites
Problem-based learning	<ul style="list-style-type: none"> <li>The GLOBE Program <a href="http://www.globe.gov">http://www.globe.gov</a></li> <li>Pathfinder Science <a href="http://www.pathfinderscience.net">http://www.pathfinderscience.net</a></li> <li>International Schools CyberFair <a href="http://www.gsn.org/gsh/cf/index.html">http://www.gsn.org/gsh/cf/index.html</a></li> <li>WISE (Web-based Inquiry Science Environment) <a href="http://wise4.berkeley.edu">http://wise4.berkeley.edu</a></li> </ul>	Explore topics, obtain and analyze data, or participate in simulated problem solving with other students
Social action projects	<ul style="list-style-type: none"> <li>IEARN Network <a href="http://www.iearn.org">http://www.iearn.org</a></li> <li>Earth Day Groceries <a href="http://www.earthdaybags.org">http://www.earthdaybags.org</a></li> <li>Give Water a Hand <a href="http://www.uwex.edu/erc/gwah">http://www.uwex.edu/erc/gwah</a></li> <li>TakingITGlobal <a href="http://www.tigweb.org">http://www.tigweb.org</a></li> </ul>	Discuss and create solutions for social or environmental problems with other students

**Problem-based learning.** Ak (2011) described **problem-based learning (PBL)** as “an approach of teaching and learning that requires the student to apply higher level learning processes” (p. 4). Casia and Zubiaga (2010) noted that PBL is an authentic way of learning that provides students with real-life experiences that “make use of real-life scenarios to

stimulate students’ prior knowledge and to provide a meaningful context” (p. 37). Pepper (2009) stated that “problem-based learning is problem-first learning because it is the problem which defines the learning” (p. 38). This kind of problem solving can take many forms, four of which are described here:

## DOES SOCIAL NETWORKING PROMOTE CYBERBULLYING?

Take a position for or against (based either on your own position or one assigned to you) 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.

"A person is bullied when he or she is exposed, repeatedly and over time to negative actions on the part of one or more other persons, and he or she had difficulty defending him or herself" (see <http://www.olweus.org/public/bullying.page>). The number of teens who are bullied online is increasing as

social networking sites become ubiquitous. Today 73% of United States teens use one or more online social network sites, and 37% of these teens use them on a daily basis. In 2010, between 21 and 30% of United States youth have harassed others online (see <http://www.cyberbully411.com/who-cyberbullies>). An important distinction between teens bullied on social networks and those bullied elsewhere is that the former are more likely to report it. Some argue that the very nature of social networking promotes cyberbullying. Others point to the meager attention given to the problem by parents, educators, schools, and policy makers. Some people have pointed to the lack of online etiquette (netiquette), and few safe-browsing skills exhibited by teens. Do you see evidence that bullying behavior is worse in social networks? What is the school's role in reducing cyberbullying?

- » **Collaborative problem solving**—This model involves several students or student groups working together to solve a problem. These kinds of lessons were dubbed **webquests** by Bernie Dodge in 1995 at San Diego State University and became a model for teachers across the country in creating their own lessons. All of these lessons give students a scenario and a task to do in response to that scenario; usually they have a problem to solve or a project to complete.
- » **Parallel problem solving**—In this strategy, students in a number of different locations work on similar problems. They solve a problem independently and then compare their methods and results or build a database or other product with information gathered during the activity.
- » **Data analysis**—These activities give students access to data from real phenomena, such as weather or solar activity. Using these data, students are able to answer questions and solve problems posed by their teachers, their peers, and themselves.
- » **Simulated activities**—These are the web equivalent of simulation software. For example, Spinello and Fischbach (2008) found that students who participated in online simulations produced higher exam scores

than those who participated in the traditional face-to-face environment. There are numerous simulation activities available for K–12 education today.

**Social action projects.** In **social action projects**, students are responsible for learning about and addressing important, global social, economic, political, or environmental conditions. For example, students collaborating on a peace project might write congressional representatives to voice concerns and present their viewpoints. The emphasis in this kind of project is collaboration to offer solutions to an issue of practical community (global or local) concern. Numerous Adventure Learning (Doering, 2006) projects have focused on social issues, such as climate change and sustainability (<http://www.eartheducation.com>) (see Figure 1).

### Integration Strategies for Web-Based Activities

These types of projects help address a variety of classroom needs, and it is this match of activity types with needs that defines and shapes integration strategies. Web-based projects are so rich in resources and learning possibilities that each one can usually be used with more than one of the integration strategies discussed next. Table 2 identifies good

**FIGURE 1 Earthducation Adventure Learning**



Source: Courtesy of Earthducation Adventure Learning Series, <http://www.earthducation.com>. Learning Technologies Media Lab, University of Minnesota, <http://lt.umn.edu>. Reprinted by permission.

## TECHNOLOGY INTEGRATION EXAMPLE 1

### SUPPORT FOR STUDENT RESEARCH

**TITLE:** Connecting Science Students with NASA Resources

**CONTENT AREA/TOPIC:** Earth science

**GRADE LEVELS:** All grades

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: Science; Information, Media, and Technology Skills: Access and evaluate information, use and manage information; ICT: Apply technology effectively

**DESCRIPTION:** The project begins by having students learn how to analyze photographic detail. They then obtain WORF images from four Earth locations, analyze them, and document their findings. Each student develops five questions he or she would like to ask in a videoconference or online session with NASA experts. Each class involved in the project forwards its best ten questions, which the experts address in a live online session.

**Source:** Based on Peterson, R., Starr, B., & Anderson, S. (2003). Real NASA inspiration in virtual space. *Learning and Leading with Technology*, 31(1), 14-19.

sources of award-winning, web-based lesson plans, activities, and collaborative projects, and the Top Ten Feature showcases ten great resources for integrating the Internet into your curriculum.

**Support for student research.** Students frequently use websites and web-based video resources and videoconferencing to gain insights into topics they are studying and to locate information for research papers and presentations. This work may be in the form of individual or group-based research projects or **electronic mentoring**. (See Technology Integration Example 1.)

Strategies in which students write for distance audiences help motivate them to write more and to do their best writing. Activities might include forming keypals and electronic publishing. (See Technology Integration Example 2.)

## TECHNOLOGY INTEGRATION EXAMPLE 2

### MOTIVATION FOR WRITING

**TITLE:** Fractured Fairy Tales

**CONTENT AREA/TOPIC:** Language arts, literacy

**GRADE LEVELS:** 3-6

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: English; Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information; ICT: Apply technology effectively; Social and cross-cultural skills: Work effectively in diverse teams

**DESCRIPTION:** Students use traditional and fractured fairy tales to study story structure. After reading and examining several traditional and fractured fairy tales, students work in groups to plan their own original fractured fairy tale, using the online *Fractured Fairy Tales* tool as an idea generator. Each group then publishes its story using either presentation software (e.g., *PowerPoint*) or a collaborative website (e.g., *Google Docs* or *Google Sites*), adding images and other linked media to enhance the tale. Groups share their stories with the entire class and can vote on the best retelling of a fairy tale.

**Source:** Based on the lesson *Once Upon a Link: A PowerPoint Adventure with Fractured Fairy Tales* at the readwritethink website: <http://www.readwritethink.org/classroom-resources/lesson-plans/once-upon-link-powerpoint-1043.html>

**TABLE 2** Web-Based Lessons and Projects

Source	Description	Content Areas
<b>Annenberg Channel</b> <a href="http://www.learner.org/interactives">http://www.learner.org/interactives</a>	"Exhibits" or web-based explorations of concepts or themes depicted in the Annenberg video resources	All content areas—mostly science, geography, and history
<b>Camp Silos</b> <a href="http://www.campsilos.org">http://www.campsilos.org</a>	Interactive lessons	Farming and prairie life
<b>Center for Improved Engineering and Science Education (CIESE)</b> <a href="http://www.ciese.org/collabprojs.html">http://www.ciese.org/collabprojs.html</a>	Collaborative projects that use real-time data available from the Internet	Science and mathematics
<b>Consumer Jungle</b> <a href="http://www.consumerjungle.org">http://www.consumerjungle.org</a>	Interactive lessons from the Young Adult Consumer Education Trust	Consumer skills
<b>Exploratorium: The Museum of Science, Art, and Human Perception</b> <a href="http://www.exploratorium.edu/educate/index.html">http://www.exploratorium.edu/educate/index.html</a>	How-to descriptions of classroom projects	Science
<b>The Franklin Institute Online</b> <a href="http://www.fi.edu/learn/index.php">http://www.fi.edu/learn/index.php</a>	Lesson plans and classroom activities	Science
<b>The Global Schoolhouse</b> <a href="http://www.globalschoolnet.org">http://www.globalschoolnet.org</a>	Clearinghouse for more than 2,000 online collaborative projects, organized by topic, grade, and project date	All content areas
<b>GoNorth! Adventure Learning Series</b> <a href="http://www.polarhusky.com">http://www.polarhusky.com</a>	Comprehensive K-12 curriculum and online activities	Science, social studies, literacy, math, and physical education
<b>FossWeb</b> <a href="http://www.fossweb.com">http://www.fossweb.com</a>	Interactive, inquiry-based science activities for K-8	Science
<b>Kinder Art</b> <a href="http://www.kinderart.com">http://www.kinderart.com</a>	How-to lessons and activities	Art
<b>National Archives Docs Teach</b> <a href="http://docsteach.org">http://docsteach.org</a>	Access and create custom lessons and activities using primary sources from the National Archives	History and social studies
<b>National Geographic Education</b> <a href="http://education.nationalgeographic.com/education/edu">http://education.nationalgeographic.com/education/edu</a>	Lesson plans, tools, and activities for grades K-12	Geography, social studies, and science
<b>National Geophysical Data Center</b> <a href="http://www.ngdc.noaa.gov/education/education.html">http://www.ngdc.noaa.gov/education/education.html</a>	Collections of resources on various topics	Science and geography
<b>National Wildlife Federation</b> <a href="http://www.nwf.org/Get-Outside/Be-Out-There/Educators/Lesson-Plans.aspx">http://www.nwf.org/Get-Outside/Be-Out-There/Educators/Lesson-Plans.aspx</a>	Lesson plans to introduce students to life science, ecology, wildlife biology, scientific identification, and observation	Science
<b>Teacher's Desk Lesson Plans</b> <a href="http://www.teachersdesk.com/lessons/lessons.htm">http://www.teachersdesk.com/lessons/lessons.htm</a>	Classroom lessons and projects	All content areas
<b>Teaching with Historic Places</b> <a href="http://www.nps.gov/nr/twhp/descrip.htm">http://www.nps.gov/nr/twhp/descrip.htm</a>	More than 130 lesson plans covering historic places across the United States	History and social studies
<b>Tramline's Virtual Field Trips</b> <a href="http://www.tramline.com">http://www.tramline.com</a>	Structured and guided teacher-designed "field trips" through a series of websites and dozens of topics	All content areas



The following powerful web-based lessons and projects have proven successful in classrooms around the country.

SOURCE	TRACK	SELECTION
Writing with Writers ( <a href="http://teacher.scholastic.com/writewit">http://teacher.scholastic.com/writewit</a> )	<b>1</b>	In this series of writing projects, students work with authors, editors, and illustrators to develop their skills in various genres. They then publish their work online to share with other young writers at this Scholastic-sponsored website.
Phet Interactive Simulations ( <a href="http://phet.colorado.edu/en/simulations/category/new">http://phet.colorado.edu/en/simulations/category/new</a> )	<b>2</b>	This website presents students with an opportunity to experience numerous interactive science simulations ranging from building a molecule to forces and motions.
Go North! Adventure Learning Series ( <a href="http://www.polarhusky.com">http://www.polarhusky.com</a> and <a href="http://cehd.umn.edu/adventure">http://cehd.umn.edu/adventure</a> )	<b>3</b>	In these projects, students explore a different Arctic location annually while following a team of explorers, scientists, and educators as they dogsled throughout the Arctic. There is a comprehensive K-12 curriculum teachers can employ while their students collaborate in the collaboration zones, participate in the expert chats, send a note of encouragement to Team GoNorth! through the send-a-note feature, participate in the weekly trivia game, and adopt a Polar Husky sled dog. There are over 3,000 educational web pages to be explored.
WeatherScope: An Investigative Study of Weather and Climate ( <a href="http://www.k12science.org/curriculum/weatherproj2/en">http://www.k12science.org/curriculum/weatherproj2/en</a> )	<b>4</b>	Schools pretend that they have been selected by a world-famous meteorological institution to conduct an investigation and report on local and world weather and climate. To complete the assignment, they are shown how to create weather instruments and how to access the Internet to locate real-time weather information from around the world.
Journey North ( <a href="http://www.learner.org/jnorth">http://www.learner.org/jnorth</a> )	<b>5</b>	Students study wildlife migration and seasonal change by sharing their field observations with classmates across North America. They track the coming of spring through the migration patterns of animals, such as monarch butterflies, bald eagles, robins, hummingbirds, whooping cranes, the budding of plants, changing sunlight, and other natural events.
Digital Storytelling: An ePals Project ( <a href="http://www.epals.com/projects/info.aspx?DivID=Digital_overview">http://www.epals.com/projects/info.aspx?DivID=Digital_overview</a> )	<b>6</b>	ePals invites classes around the world to explore digital storytelling as a means of promoting cross-cultural understanding. Students create and share their digital stories to build meaningful connections with others. Throughout the process they participate in an email exchange to discuss the process.
ReadWriteThink ( <a href="http://www.readwritethink.org">http://www.readwritethink.org</a> )	<b>7</b>	This website provides lessons, standards, web resources, and student materials for supporting literacy in K-12 reading and language arts classrooms. A variety of resources are at this site, providing educators and students with access to free, high-quality, Internet-based content.

<p>GeoThentic: Authentic Online Geography (<a href="http://www.geothentic.umn.edu">http://www.geothentic.umn.edu</a>)</p>	<p><b>8</b></p>	<p>In this exciting online environment, students use multiple scaffolds to solve authentic geographic problems using geospatial technologies such as <i>Google Earth</i>. Ranging from situated movies that announce the problem as if it were a live television broadcast to screen-capture videos, collaboration zones, and intelligent agents, students and teachers alike can use the environment to assist in all aspects of using geospatial technologies within social studies and science classrooms.</p>
<p>Global Grocery List Project (<a href="http://www.landmark-project.com/ggl/index.html">http://www.landmark-project.com/ggl/index.html</a>)</p>	<p><b>9</b></p>	<p>In this ongoing email project, students visit their local grocery stores, record the prices of items on the grocery list, and share their prices with classes all over the world. The result is a growing table of current, peer-collected data that can be used in math, social studies, science, and health classes.</p>
<p>National Library of Virtual Manipulatives (<a href="http://nlvm.usu.edu">http://nlvm.usu.edu</a>)</p>	<p><b>10</b></p>	<p>The National Library of Virtual Manipulatives (NLVM) is a library of uniquely interactive, web-based virtual manipulatives or concept tutorials, mostly in the form of Java applets, for mathematics instruction (K–12 emphasis).</p>

**Practice for information literacy skills.** Locating and using information from Internet sources has become a key part of classroom learning. It is important that students have opportunities to learn how to use web resources efficiently and effectively. Possible activities include individual and cooperative research projects. (See Technology Integration Example 3.)

**Visual learning problems and solutions.** Many sites provide access to data, images, animations, and videos that help students understand complex problems and guide them in creating their own solutions. Possible activities include individual and cooperative research projects, as well as problem-based learning projects. (See Technology Integration Example 4.)

**Development of collaboration skills.** Web-based projects provide rich opportunities for students to learn how to work together to solve problems. Many web-based projects call for students to produce a product, such as a brochure, web page, or multimedia presentation. McGrath (2004) describes ways to help make these collaborative projects most productive. Projects that promote collaboration skills include individual and cooperative research projects, electronic publishing, group development of products, problem-based learning, and social action projects. (See Technology Integration Example 5.)

**Multicultural experiences.** Many web-based projects focus on broadening students’ perspectives on their own and other cultures, and providing insights into how their culture

relates to others in the world. Appropriate web-based activities include electronic (virtual) field trips and social action projects. (See Technology Integration Example 6.)

## Support for Web-Based Learning Activities

On the Virtual Architecture site, Harris points out that websites could perform several functions to support web-based learning activities. The following discussion of website support functions is based on Harris’s description. Note that a single website can serve one or more of these functions (see Table 3).

**Function #1: Project overview, announcement, and application.** Sites can introduce the goals and purposes of existing projects and invite people to participate. For example, the *GeoThentic* website (<http://lt.umn.edu/geothentic>) provides an overview of the project and gives participants a place to sign up, as shown in Figure 2.

**Function #2: Tutorial instruction.** A website can serve to deliver actual instruction and information on a topic or project. For example, *Mind Lab* (<http://jvsc.jst.go.jp/find/mindlab/english/index.html>) provides themed “sessions” followed by “trials” where users experience psychological experiments, such as “Constructing a 3-D world from 2-D images” (see Figure 3).

**Function #3: Information summaries and exchanges.** Students can use websites to add information (media, text, etc.)



## TECHNOLOGY INTEGRATION EXAMPLE 3

### PRACTICE FOR INFORMATION LITERACY SKILLS

**TITLE:** Westward Expansion

**CONTENT AREA/TOPIC:** Social studies, history

**GRADE LEVELS:** 7–12

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: Social studies; Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information; Critical Thinking and Problem Solving: Make judgments and decisions

**DESCRIPTION:** Begin by asking the class to hypothesize why Americans may have wanted to move West in the middle of the 19th century. Discuss general reasons why humans leave one place to move to another, as well as the cultural and political climate of the United States during this era. Have students work in pairs researching, examining, and discussing primary documents and images from this time period available online through the National Archives. Using tools available at the National Archives *Docs Teach* website, or a collaborative online tool such as *Google Docs* or *Google Sites*, students then choose five to ten documents to share with the class and place their documents in chronological sequence, compiling a list of possible reasons why Americans moved westward during this era. Groups share their findings with the class.

**Source:** Based on the lesson *Reasons for Westward Expansion* at the National Archives Experience *Docs Teach* website: <http://docsteach.org/activities/104>

## TECHNOLOGY INTEGRATION EXAMPLE 4

### VISUAL LEARNING PROBLEMS AND SOLUTIONS

**TITLE:** OF2—Our Footprints, Our Future

**CONTENT AREA/TOPIC:** Environmental science

**GRADE LEVELS:** Elementary, middle school, and high school

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: English; Information, Media, and Technology Skills: Access and evaluate information, use and manage Information.

**DESCRIPTION:** OF2—*Our Footprints, Our Future* is an international initiative that encourages individuals younger than 19 from around the world to use online tools and resources to measure their carbon footprint and develop ways to reduce their carbon usage. The goal of OF2 is to engage students, their families, schools, and communities to reduce the total global carbon footprint. Students input data based on their lifestyles into an online carbon footprint calculator located at <http://calc.zerofootprint.net/youth> (for younger students) or <http://earthhour.zerofootprint.net> (for older students) to estimate their annual contribution. Because the tool has been adapted to recognize different cultural and socio-economic settings, housing, modes of transportation, and food consumption, students will be able to find a close estimate. Once students receive their results, they can blog or discuss in groups how their lifestyle affects climate changes around the world.

**Source:** Based on the lesson *OF2—Our Footprints, Our Future* at iEARN website: <https://media.iearn.org/projects/of2>

to a collection that will be shared with others. For example, *Planet Connect* (<http://www.planet-connect.org>) is a site where high school students interested in the environment can share ideas in solving environmental issues (see Figure 4).

**Function #4: Communication and support.** A website can serve as a virtual meeting place to support students' communications as they work together at distant locations. These websites can be even more helpful if they build in streaming video or videoconferencing. They may also offer links to resources to support project activities and make gathering information for project work more efficient (<http://mathforum.org>). See an example in Figure 5.

**Function #5: Displays of past and current student work.** Websites can be used as web publication centers in which students show examples of their poems, stories, pictures, and multimedia products. Some sites also show ongoing descriptions of past, current, and planned project activities (<http://www.kidpub.com>). See an example in Figure 6.

**Function #6: Project development centers.** Websites are sometimes set up for the specific purpose of inviting new distance learning projects. The Global SchoolNet Foundation (<http://globalschoolnet.org>) has hundreds of existing projects and invites teachers around the world to register new ones. See an example in Figure 7.

## TECHNOLOGY INTEGRATION EXAMPLE 5

### COLLABORATIVE SKILLS DEVELOPMENT

**TITLE:** Writing with Scientists

**CONTENT AREA/TOPIC:** Science, writing

**GRADE LEVELS:** High school

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Core subjects: Science; Information, Media, and Technology Skills: Access and evaluate information, Use and manage Information; ICT, Apply technology effectively

**DESCRIPTION:** *Writing with Scientists* helps students write a research paper, and takes them through the process of describing their questions and hypothesis, collecting data and other information, analyzing results, writing conclusions, presenting sources in a bibliography, and, finally, publishing their report online to be shared with their classmates or other online communities. In this activity, students are provided with sample writings as well as recorded audio description of each process by a scientist from the National Science Foundation. *Writing with Scientists* can be used if students have already done research on a topic of interest or they may use it as a guide to set up goals before gathering research and data.

**Source:** Based on the lesson *Writing with Scientists* at the Scholastic site: <http://teacher.scholastic.com/activities/sciencewriting/tguide/index.htm>

## TECHNOLOGY INTEGRATION EXAMPLE 6

### MULTICULTURAL EXPERIENCES

**TITLE:** Immigrant Experiences

**CONTENT AREA/TOPIC:** Social studies, history

**GRADE LEVELS:** Middle school

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency

**21ST CENTURY SKILLS:** Core subjects: Social studies; Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information

**DESCRIPTION:** After researching the geography and history of their own town or selected regions of the world, students share their finding with their peers in an online forum. Students practice numerous research skills, such as interviewing and document analysis, while acquiring an understanding of how the history of the region they studied is connected to their lives. Both a publication and web page can be produced.

**Source:** Based on the lesson *Local History Project* at iEARN website: <http://media.iearn.org/projects/localhistory>

**TABLE 3** Website Support Functions

Function	Description	Sample Site
1. Project overview, announcement, and application	Describes existing projects and offers signup location	<i>Westward Ho!</i> <a href="http://www.cyberbee.com/wwho">http://www.cyberbee.com/wwho</a>
2. Tutorial instruction	Offers instruction and information on topics	<i>Mind Lab</i> <a href="http://jvsc.jst.go.jp/find/mindlab/english/index.html">http://jvsc.jst.go.jp/find/mindlab/english/index.html</a>
3. Information summaries and exchanges	Allows information to be added to a collection that will be shared with others	<i>Planet Connect</i> <a href="http://www.planet-connect.org">http://www.planet-connect.org</a>
4. Communication and support	Provides virtual meeting places to support students' communications and resources to support project work	<i>Math Forum</i> <a href="http://mathforum.org">http://mathforum.org</a>
5. Displays of past and current student work	Shows examples of students' work in web publication centers	<i>KidPub</i> <a href="http://www.kidpub.com">http://www.kidpub.com</a>
6. Project development centers	Invites the creation of new distance learning projects	Global SchoolNet Foundation <a href="http://www.gsh.org">http://www.gsh.org</a>

**FIGURE 2** Example of Project Overview, Announcement, and Application: *GeoThentic*



Source: Courtesy of GeoThentic, <http://lt.umn.edu/geothentic>. Learning Technologies Media Lab, University of Minnesota, <http://lt.umn.edu>. Reprinted by permission.

**FIGURE 3** Example of Tutorial Instruction: *Mind Lab*



Source: Mind Lab, <http://jvsc.jst.go.jp/find/mindlab/english/index.html>. Reprinted by permission.

## Assessing the Quality of Web-Based Lessons

Hundreds of web-based activities are available for teachers to use in their classrooms or join online; some work better than others. How can teachers evaluate the quality of given activities and select those that will work best for their students? One useful assessment instrument is the *Rubric for Evaluating WebQuests*, found at <http://webquest.sdsu.edu/webquestrubric.html>. Although webquests represent just one of many possible types of web-based lessons, the elements of this rubric apply to most web-based lessons.

**FIGURE 4** Example of Information Summaries and Exchanges: *Planet Connect*



Source: Planet Connect, <http://www.planet-connect.org>. Reprinted by permission.

**FIGURE 5** Example of Communication and Support: *Math Forum*



Source: The Math Forum @ Drexel, <http://www.mathforum.org>. Reproduced with permission from Drexel University, copyright 2011 by The Math Forum @ Drexel. All rights reserved.

## DEVELOPING WEB-BASED LESSONS

Developing personal, professional, school, and project web pages and websites has become an excellent way for both teachers and students to learn the power of the Internet, participate in cooperative projects, and display project results. This section describes the resources needed to develop

**FIGURE 6** Example of Student Work: *KidPub*



Source: KidPub, <http://www.kidpub.com>. Copyright 1995, 2011 KidPub Press LLC. Reprinted by permission.

**FIGURE 7** Example of Project Development: Global SchoolNet



Source: Copyright GlobalSchoolNet.org—Linking Kids Around the World. Reprinted by permission.

web-based projects and lessons and also outlines procedures required to create effective web-based products.

## Website Authoring Tools

Only a few years ago, web pages could not be developed without program authoring languages and scripting tools. Now, thanks to web page development software, it is possible to develop whole sites without writing a line of code or script. However, even if one uses a web development tool, such as Adobe *Dreamweaver*, that generates code automatically, it is good to know enough about each of the major program authoring languages to make minor adjustments to developed pages or to troubleshoot problems as they occur. Program authoring languages include Hypertext Markup Language (HTML and HTML 5), Java, **Virtual**

**Reality Modeling Language (VRML)**, PHP, ASP.NET, ActionScript in Adobe *Flash*, and many more. Also described here are web page and website software tools that allow developers to create web products without programming. There are also numerous open-source options for web development (see Open-Source Options).

**HTML and HTML 5.** **HTML** is the Internet standard for how web pages are formatted and displayed. An example of HTML and the beginning of the page it generates is shown in Figure 8. (Note that the example displays only the beginning of the complete code.) **HTML 5** is the latest revision of the HTML standard and has become mainstream since Adobe *Flash* is not supported on products such as the Apple iPad. Adobe *Flash* is no longer needed as HTML 5 can provide the features of *Flash* in a more efficient manner.

# Free open source OPTIONS for Free Software for Web-Based Lesson Development

## INSTRUCTIONAL OPTIONS

## FREE SOURCES

### Web Development

*openWYSIWYG*: <http://www.openwebware.com>  
*NVU* (pronounced "N-view,"): <http://net2.com/nvu>  
*TinyMCE*: <http://tinymce.moxiecode.com/>  
*eIRTE*: <http://elrte.org/>

**FIGURE 8** Sample Web Page with Partial HTML Code



Source: Courtesy of Learning Technologies Media Lab, University of Minnesota, <http://lti.umn.edu>. Reprinted by permission.

**Java.** Originally called OAK, **Java** is a high-level programming language developed by Sun Microsystems. An object-oriented language similar to C++, it was originally developed for more general use but has become popular because of its ability to allow users to create interactive graphic and animation activities on web pages. Many developed Java applications, called **Java applets**, are available for downloading from a web server (<http://java.sun.com/applets>) and can be run on any computer that has a Java-compatible web browser. Java used to be extremely popular as it made web page features such as animations and special effects, graphics and buttons, interactive displays, and web data collection forms possible. Now, many of these features are accomplished through other means that are described later.

**VRML.** Although not in common use by most developers, **VRML** develops and displays 3-D objects on web pages. These objects give the illusion of being “real” much more than videos or animations do, and they can be used to create multiuser virtual worlds, which are sometimes referred to as MUDs (multiuser dimensions or domains). These virtual areas allow several people to interact at once using graphic representations of themselves. We now have Web3D open standards that make use of VRML and support the delivery of Educational Virtual Environments (EVEs). According to Lleronutti and Chittaro (2007), these EVEs have amazing potential for both learning and training as they can provide opportunities to educate people with a reduction in costs and greater safety.

**PHP and Microsoft ASP.NET.** **PHP** and **ASP.NET** are server-side applications, meaning that they must be installed on a server to be used in web development. PHP originally stood for personal home page and was developed in 1994, while ASP.NET was first released in 2002. PHP and ASP.NET are scripting languages that generate HTML source code to be interpreted by the end-user’s browser to create dynamic web pages.

**Javascript and other programming languages.** **Javascript** is an object-oriented scripting language that is client-side, meaning it is implemented as part of a web browser. Javascript and other programming languages, such as PEARL, Java, and C++, are used to create dynamic web sites.

**ActionScript in Adobe Flash.** **ActionScript** within Adobe Flash software provides an advanced authoring environment for creating content for the web, a mobile device, or virtually any digital platform. In applications ranging from instructional media and games to interactive websites, Flash can take a typical HTML-designed website and make it into an interactive experience. An example of education software using Flash is the University of Minnesota’s VideoANT software developed by Brad Hosack. VideoANT is an online environment synchronizing web-based video with timeline-based text annotations (see Figure 9).

**Web development software.** Web development tools generate HTML, Javascript, and other code so that users can develop web page and website products without having to know programming languages. Web development

**FIGURE 9** Flash-Based Learning Environment: *VideoANT*



Source: Courtesy of University of Minnesota College of Education & Human Development, <http://www.cehd.umn.edu/ats>. Reprinted by permission.

tools range from simple programs for development (e.g., *Google Sites* and *TeacherWeb*) to complex, full-featured packages (e.g., Adobe *Dreamweaver*) that allow development of multiple-page websites with sophisticated multimedia components. View the Adapting for Special Needs feature for this chapter to learn about web accessibility for learners with special needs.

## Downloading Images, Programs, and Plug-Ins

Several of the resources that are useful in both developing and using web pages can be **downloaded**—that is, transferred from a website to your computer—for free from company sites. Some of these downloadable resources are images, programs (e.g., updated versions of browsers), extensions, and **plug-ins** or “player” programs that allow you to play audio and video clips in web pages. Most of today’s browsers come with the plug-ins already installed when you download the browser.

**Downloading images.** You can use your browser to “capture” or download almost any image you see from a web page and store it on your computer. Once you download an image, you can use it in your own web pages. Downloading an image from the Internet is easy, but

remember that many images you find on web pages are copyrighted. Their legal use is determined by copyright law and by the owner of the website. If you are not sure if you can use an image legally, contact the website owner to request permission.

After you save an image on your computer, normally accomplished by right-clicking on an image and selecting “Save Image As,” you can insert it in documents or other web pages. However, you may need to change the image format from the original file format. Several **image formats**, or ways of storing images, have been developed over the years to serve various purposes: either a certain computer or operating system required it, or certain formats were found to deal better with differences among image types (e.g., photos rather than drawn images). You can tell the format of an image by the suffix in its filename. The most common formats are:

- » **GIF**—Stands for “Graphics Interchange Format.” Used for drawn images, illustrations, clip art, or animations.
- » **JPEG**—Stands for “Joint Photographic Experts Group,” and the filename extension is .jpg. Used for photographs.

Images downloaded from web pages will most commonly be in JPEG format. If you want to use images in your own



## ADAPTING FOR SPECIAL NEEDS

### Web Page and Website Development

**W**eb accessibility is a critical aspect of effective website development and web page design. Federal law requires all agencies receiving federal funds to demonstrate compliance with web accessibility standards. When web designers fail to consider the needs of individuals with disabilities, they may use inappropriate design techniques, such as the following:

- » Text may be inside an image, which makes it impossible to enlarge
- » Colors cannot be adjusted to improve text-to-background contrast
- » Alternatives to mouse controls are not provided for navigation
- » Text descriptions do not accompany visual images

In these situations, equitable access is denied to individuals with disabilities since they are prevented from accessing the information that is available to their non-handicapped peers. The following sites give useful information on how to design web pages and websites for maximum accessibility:

- » **CSS Zen Garden** (<http://www.csszengarden.com>)—To experience how Cascading Style Sheets (CSS) can be used to alter how a web page looks while maintaining the same content. This is an important advance as it means that users are able to apply their own style sheet to a web page to alter the readability in ways that are personally beneficial.
- » **Readability** (<https://www.readability.com>)—Explore free tools for web and mobile devices. Users will discover that they can enhance the reading experience by customizing the CSS they use to view web-based information.
- » **Ten Quick Tests for Website Accessibility** (<http://www.webcredible.co.uk/user-friendly-resources/web-accessibility/testing-web-accessibility.shtml>)—Describes ten easy ways to assess the accessibility of a specific web page.
- » **WAVE** (<http://webaim.org/products>)—A free, web-based tool to help web developers make their web content more accessible.

Contributed by Dave Edyburn

web pages, they must be in either JPEG or GIF formats. If you want to change an image to one of these formats, you need to bring it into an image manipulation program (e.g., Adobe *Photoshop*) and save it in either GIF or JPEG format.

**Downloading programs and plug-ins.** Web browsers made the Internet visual, but subsequent developments gave it sound and motion. Special programs called plug-ins have been created to allow people to see and hear the multimedia features that make the Internet increasingly lifelike. Although plug-ins tend to change and update frequently, the Internet has a built-in way of allowing people to take full advantage of its multimedia features and to keep up with advancements required for their use. Internet users can download many of the plug-ins directly from the company sites. In fact, one of the most recent plug-ins allows users to view *Google Earth* within a web browser.

Five of the most commonly downloaded programs and plug-ins are described here and summarized in Table 4.

1. **Updated browser versions**—Most new computers come with a browser program already installed. However, browsers update frequently, constantly adding new features and capabilities. It is necessary to use an up-to-date version in order to see newer Internet features. You can download newer versions of browsers from the Apple, Firefox, and Microsoft websites.
2. **PDF reader**—This program lets you see **Portable Document Format** files. These are pages stored as im-

ages so they may be printed out with a page appearance identical to the original document. A PDF format is particularly important when the original text contains both print and images or when one wants to see the appearance of the original document. For example, one might photograph and store the pages of the Declaration of Independence so that history students could see them. Numerous companies have developed software for creating PDF files from any type of file. For example, if one owns a Macintosh computer that uses a recent operating system (OS 10.5 and higher), one can create a PDF file from the Print menu. A program to create PDF files from Adobe, Inc., is also available for purchase, but the Adobe *Reader* viewer plug-in required to see already-stored PDF files is available free from Adobe, Inc., and Apple has its own program called *Preview*.

3. **Streaming video and audio player plug-ins**—An exciting Internet capability is being able to see action or hear sounds live on the Internet. **Streamed video and audio** sends or “streams” images and sounds a little at a time so one need not download the files completely before using the contents. This is especially useful for large videos that take a long time to download. Video quality is dependent on the quality and speed of the line connecting the computer to the Internet.
4. **Movie player plug-ins**—Videos that have been digitized and stored as movie files may be viewed through a plug-in. Programs such as Apple’s *QuickTime* are used to cre-

**Table 4** Popular Programs to Download for Web Page Development and Use

Type of Program	Program Name	Download Source
Browsers	<i>Safari</i> <i>Firefox</i> <i>Internet Explorer</i> <i>Chrome</i>	<ul style="list-style-type: none"> <li>• Apple: <a href="http://www.apple.com/safari">http://www.apple.com/safari</a></li> <li>• Mozilla: <a href="http://www.mozilla.com">http://www.mozilla.com</a></li> <li>• Microsoft: <a href="http://www.microsoft.com/ie">http://www.microsoft.com/ie</a></li> <li>• Google: <a href="http://www.google.com/chrome">http://www.google.com/chrome</a></li> </ul>
PDF reader	<i>Adobe Reader</i>	<ul style="list-style-type: none"> <li>• Adobe: <a href="http://get.adobe.com/reader">http://get.adobe.com/reader</a></li> </ul>
Streaming video and audio players	<i>RealPlayer</i> (audio/video)	<ul style="list-style-type: none"> <li>• RealNetworks: <a href="http://www.real.com">http://www.real.com</a></li> </ul>
Movie players	<i>QuickTime</i>	<ul style="list-style-type: none"> <li>• Apple: <a href="http://www.apple.com/quicktime">http://www.apple.com/quicktime</a></li> </ul>
Animation players	<i>Adobe Flash</i>	<ul style="list-style-type: none"> <li>• Adobe: <a href="http://get.adobe.com/flashplayer">http://get.adobe.com/flashplayer</a></li> </ul>

ate these movies, which usually are shot with a camcorder and stored in a .mov format. To see them, one needs *QuickTime* software. Although originally designed as a movie player, more recent versions of *QuickTime* can also be used with streaming video and audio.

5. **Animation plug-ins**—Special programs that create animated content (e.g., sliding menus, games, movies) for the web also come with their own players, such as Adobe *Flash*.

## File Transfer Options: FTP Programs and Uses

When teachers and students engage in distance collaborations, they often need to exchange files of their work. There are numerous ways this can be accomplished, such as an email attachment or using *Google Docs*. However, the most common way to transfer large documents, graphic files, and programs from one computer to another is called **File Transfer Protocol (FTP)**.

An FTP uploads files to servers on the Internet. FTP requires software (e.g., *WS\_FTP*, *Cyberduck*) and a server set up to receive files. (Most computer systems also have built-in FTP capabilities, but they must be compatible with the server to which the files are being sent.) After teachers and students create web pages, they usually use FTP software to send the files to the school or district server. FTP software allows them to both send files and to view, move, or delete files that they have already sent.

Most schools or districts that have their own server also have their own FTP software and procedures they want teachers to follow for uploading new files. However, if teachers use another site (e.g., one made available to them by an Internet service provider, or ISP), they have to contact the web administrator of that server for the usernames and passwords required to send files via FTP.

## Procedures for Developing and Evaluating Websites

Teachers and students can use two different strategies for creating their own web pages and websites:

- » Creating pages from scratch using web development software such as Adobe *Dreamweaver*.
- » Using one of the many template-based web development tools, such as *TeacherWeb* (shown earlier and available at [www.teacherweb.com](http://www.teacherweb.com)) or *WordPress* ([www.wordpress.org](http://www.wordpress.org)).

To implement either of these strategies, you will need three different resources:

1. **Web development software**—Although you can create pages by programming them in HTML code, teachers will find that using web page development software is preferable; it is easier and faster, and it requires much less technical skill. As with most tool software, web page development software packages vary considerably as to features and prices. A package such as Adobe *Dreamweaver* is full featured and must be purchased. However, using a program such as *Google Sites* (<http://sites.google.com>) or *TeacherWeb* is quite easy, efficient, and rewarding.
2. **FTP software**—Depending on the type of web development software, after developing the web pages for your site, some, such as *TeacherWeb*, automatically upload your web pages to the server provided by the software company, while others require manual transfer or upload to a server to be viewed publicly. To do this, one needs FTP software, as discussed in the preceding section. If the website will be housed on a school or district server, technical personnel there may provide an FTP package, or they may want to upload the pages themselves. If the site will be on another server, contact that server's web administrator to determine the required procedures. *Google Sites* (<http://sites.google.com>) stores websites on Google's server, and thus, FTP as described is not needed. One of the most popular FTP software today is the open-source software *Cyberduck* (<http://cyberduck.ch/>).
3. **Server to house the website**—If one is going to use web development software, such as Adobe *Dreamweaver*, one will need to have a "home," that is, a computer or server on which it resides. Most teachers choose to have their website on their school or district server. In this case, they may want to learn about the procedures that have been established in their school or district for obtaining required permissions and for uploading pages to the server. However, as noted earlier, if they select a web development tool such as *TeacherWeb* or *Google Sites*, the company provides the server and teachers simply update the website residing on that server.

## Requirements and Recommendations for Developing a Website

Before you begin developing pages, consider these items:

- » **Limit sharing of personal information**—Educators may wish to limit personal information, such as pictures and telephone numbers. Educational websites normally include only first names and email addresses rather than full names and street addresses.



- » **Limit photos and large graphics**—Although this is not such an issue as it was in years past because of the increased speed of the Internet, limit the size of any photos or graphics to under 500 kilobytes (KB) if at all possible. Large files take a long time to load, which can be frustrating to users who wish to see the information on that server.
- » **Address web page criteria**—Teachers should use the same criteria for a page they wish to see in other sites. Review the criteria for effective web pages presented later in this chapter. Review other educational sites and follow their structure. Even experienced designers spend a great deal of time viewing websites to learn and understand how to display information effectively.
- » **Consider purchasing a domain name**—We all remember website URL addresses that are simple, such as Google ([www.google.com](http://www.google.com)) or GoDaddy ([www.godaddy.com](http://www.godaddy.com)), and many URL addresses reflect the content of the website. Website developers are encouraged to purchase a **domain name** that is simple and easily remembered while also reflecting the content of the website. Thus, instead of trying to remember the name of Ms. Matthew’s classroom website that has many dashes and slashes in it, one could purchase a domain name such as [www.msmatthews.com](http://www.msmatthews.com) or [www.msmatthewsclassroom.com](http://www.msmatthewsclassroom.com) and forward the domain name to where the website resides making it much easier for someone to remember. Website domain names can be purchased at numerous places, such as Network Solutions ([www.networksolutions.com](http://www.networksolutions.com)), GoDaddy ([www.godaddy.com](http://www.godaddy.com)), or register.com ([www.register.com](http://www.register.com)).

## Recommended Web Page Development Sequence

The following six steps are recommended as a sequence for web page development. As noted earlier, many website development sites now have templates that make many of these steps non-existent or much easier. For example, if a *WordPress* theme is used, the design and layout is already predetermined.

**Step 1: Wireframing and/or Storyboarding.** Planning and **designing**, the first steps in developing a website, are the most difficult and important—and most frequently neglected—of all the steps. Though most people want to get to the fun of development, planning is critical to a well-designed website. Planning can include two steps, wireframing and storyboarding, though web development experts disagree on whether both steps are necessary, and some say they may be combined. To do wireframing, map out the pages in terms of functions, giving a general idea of content

on each page and showing how users navigate from one page to another. To do this, try using cognitive mapping software such as *Inspiration*, or even sticky notes placed on large pieces of poster board to represent the web pages. To create storyboards, make a detailed sketch of the content on each page in the site. This kind of planning should include sketches of tables, navigation, photos, and details on other graphic elements that should be included.

**Step 2: Design and Layout.** The next step is to focus on exactly what the website will look like using colors, features, and layout. Most commonly, designers use software such as Adobe *Photoshop* or Adobe *Illustrator*. If your skill level does not warrant the use of this software, you can do this on paper with colored pencils or any design tool of your choice.

**Step 3: Development.** Now comes the fun step of actually developing your website on the computer using the website development tool of choice. This phase includes creating the tables, inserting the images and photos, inserting the interactive elements, and any other features you may want on your site. Although Adobe *Dreamweaver* is the most common software design program, there are many other options one can explore.

**Step 4: Testing** Developers should always be testing how the website actually looks in a web browser. Many development programs have a built-in preview system, but it is essential to test the site with an actual browser to observe how it will work when it is published on the web.

**Step 5: Publish (upload) the site.** For others to see the newly created website, place the pages on a server. This is called *publishing* the site. Use your favorite FTP program to publish your website to a server so that it is live for the public. Much like the testing and development phases, you will be uploading the website through numerous iterations to make sure it views correctly and works well on different types of web browsers.

**Step 6: Gather evaluation comments, revise, and maintain the site.** The best websites are those that are updated regularly based on user comments and the continuing insights of the developers. Obtaining user feedback may be done through interactive forms built into the page or simply through inviting emailed comments.

## Evaluating Internet Information

At a time when everything in the world seems so high tech and highly controlled, the Internet is, in some ways, a wild frontier. While there are oversight agencies that set up and monitor general items such as domain designators, no one controls who posts web pages or the quality of their content.

**Evaluating content.** The Internet’s vast information storehouse, unfortunately, contains some information that is incomplete, inaccurate, and/or out of date. It even has some sites that are works of complete fiction presented as fact. Students frequently accept as authoritative any information they find on the Internet. However, young people must learn that blind acceptance of any information (on the Internet or elsewhere) is a risky practice. An essential skill for the Information Age is being able to evaluate information critically and to look for indications that content is accurate and reliable. There are numerous rubrics and checklists available for evaluating website content. One of the most popular is *Cyberguide* at <http://www.cyberbee.com/content.pdf> (see Figure 10).

**Evaluating design.** We have learned a great deal in recent years about what makes a website functional and easy to use. However, some sites are so poorly designed that people may find it difficult or impossible to locate or read the information they have to offer. Also, what constitutes “good design” changes constantly as a result of new technologies.

## Criteria for Evaluating Web Pages and Website Design

One important way to evaluate a web page is by its design. Ultimately, a website has to have good user design, meaning that it is easy for a user to experience the features of the website. As teachers and students develop and design their own web pages, they can use the following characteristics to judge design quality:

- » **Good structure and organization**—The first page of the site indicates clearly how to navigate to other features of the site. This can be done through numerous options—from navigation at the top, bottom, or side of every page in the site. Option bars allow you to move easily around the site. Ultimately, it should be very clear how a user can find the content they are looking for on the website.
- » **Clear text and/or graphic links**—When developing a website, keep in mind that it should take no more than three clicks to find content or return to the home page of the site. One useful device for large sites provides a link to a **site map**, or at-a-glance guide to the contents.
- » **Good visual design**—Pages are designed for good readability and aesthetics. A limited number of colors and fonts are used; fonts are easy to read, and colors are selected for contrast with the background. Graphics should not distract from reading the content. You can tell from looking at an icon what information you will get when you click it.

- » **Easy navigation**—Pages should always load very quickly. It’s easy to get around in the site. Links are provided so you can get back to the main page from any part of the site. The most important information is given at the top of the page. All links work as they should. Larger sites have their own built-in search engine.

Finally, one must not overlook the importance of design in any website development. Although it may not be on top of the list when developing a classroom website, teachers themselves or teachers along with their students should think about how design and the process of design thinking is of ultimate value. A website that highlights this process is Design Thinking for Educators (see <http://www.designthinkingforeducators.com>).

## Criteria for Evaluating Student Web Products

As students begin to create their own websites, it is helpful to give them criteria in the form of rubrics that describe the quality they are aiming for in each of several aspects. Many such web page rubrics are available; one of the most popular sites for rubrics is “Kathy Schrock’s Guide for Educators” (see <http://school.discoveryeducation.com/schrockguide/assess.html>).

## DEVELOPING AND IMPLEMENTING WEB-BASED PROGRAMS AND LESSONS

There are numerous web-based projects and lessons that are available to be freely integrated into the classroom. The quality of these projects and lessons has dramatically increased over the past five years as organizations have invested their time and effort online, rather than in print. Moreover, there are more opportunities for educators to design their own web-based projects and lessons.

### Web-Based Programs

**Web-based programs** are those that would fall into the category of *completely online courses and curriculum* as defined earlier in the chapter. These are projects that allow educators to teach an entire unit on a certain topic through an online experience. Although these are not as common as individual lesson plans, they are many times more valuable to educators. Examples of these web-based projects are Adventure Learning projects; Discovery Channel’s Education portal;

**FIGURE 10 Website Content Evaluation Criteria: *Cyberguide***

WWW CYBERGUIDE RATINGS FOR CONTENT EVALUATION			
Size Title: _____	Subject: _____		
URL: _____	Audience: _____		
Purpose for exploring this site: _____			
Notes on possible uses of this site and URLs for useful linked sites: _____			
_____			
_____			
To determine the worth of the Web site you are considering, evaluate its content according to the criteria described below. Circle "Y" for "Yes", "N" for "No", "NA" for "Not Applicable."			
<b>1. First look*</b>			
A. User is able to quickly determine the basic content of the site.	Y	N	NA
B. User is able to determine the intended audience of the site.	Y	N	NA
<b>2. Information Provided</b>			
A. The author(s) of the material on the site is clearly identified.	Y	N	NA
B. Information about the author(s) is available.	Y	N	NA
C. According to the info given, author(s) appears qualified to present information on this topic.	Y	N	NA
D. The Sponsor of the site is clearly identified.	Y	N	NA
E. A contact person or address is available so the user can ask questions or verify information.	Y	N	NA
<b>3. Information Currency</b>			
A. Latest revision date is provided. Date last revised.	Y	N	NA
B. Latest revision date is appropriate to material.	Y	N	NA
C. Content is updated frequently.	Y	N	NA
D. Links to other sites are current and working properly.	Y	N	NA
<b>4. Information Quality</b>			
A. The purpose of this site is clear: business/commercial – entertainment – informational – news – personal page – persuasion.	Y	N	NA
B. The content achieves this intended purpose effectively.	Y	N	NA
C. The content appears to be complete (no "under construction" signs, for example).	Y	N	NA
D. The content of this site is well organized.	Y	N	NA
E. The information in this site is easy to understand.	Y	N	NA
F. This site offers sufficient information related to my needs/purposes.	Y	N	NA
G. The content is free of bias, or the bias can be easily detected.	Y	N	NA
H. This site provides interactivity that increases its value.	Y	N	NA
I. The information appears to be accurate based on user's previous knowledge of subject.	Y	N	NA
J. Grammar and spelling are correct.	Y	N	NA
<b>5. Further Information</b>			
A. There are links to other sites that are related to the my needs/purposes.	Y	N	NA
B. The content of linked sites is worthwhile and appropriate to my needs/purposes.	Y	N	NA
<b>Total</b>			
Based on the total of "yes" and "no" answers and your overall observations, rate the content of this site as: ___ Very useful for my information needs ___ Worth bookmarking for future reference ___ Not worth coming back to			
Comments:			
_____			
_____			
_____			
©Karen McLachlan, 7/31/2002	East Knox High School Howard, Ohio		mclachlan_k@treca.org

Source: <http://www.cyberbee.com/content.pdf>. Reprinted by permission of Karen McLachlan.

and *GeoThentic*, a program designed for students to learn about science, social studies, and technology.

- » Adventure Learning (AL) urges designers, developers, and educators to rethink their approach to online learning. AL provides students with opportunities to explore real-world issues through authentic learning experiences within collaborative online learning environments (Doering & Miller, 2009; Veletsianos & Kleanthous, 2009). Some of the most popular AL programs currently include the *GoNorth!* Adventure Learning Series ([www.polarhusky.com](http://www.polarhusky.com)) and The JASON Project (<http://www.jason.org/>) where educators follow and interact with scientists, explorers, and peers as they use a curriculum that meets state and national standards while infusing the real-world into the learning process. The benefit of the majority of these programs is that pedagogical strategies are provided for educators to integrate the web-based programs into their classrooms, thus scaffolding the educators to successfully integrate such programs. For example, as part of the *GoNorth!* curriculum, educators could choose to integrate the curriculum based on either grade level or inquiry-level.
- » The Discovery Channel provides Discovery Education (<http://www.discoveryeducation.com>), which provides curriculum, lesson plans, and digital textbooks, along with portals for administrators, teachers, parents, and students).

The next iteration of web-based programs is allowing educators and students to create their own programs. Many educators have wanted to create their own web-based programs

**FIGURE 11** Designing Web-Based Programs: *Explore 15*



Source: Courtesy of *Explore15*, Learning Technologies Media Lab, University of Minnesota, <http://lt.umn.edu>. Reprinted by permission.

and have characterized web-based programs as being elite and only possible if one has a great deal of money and time. Now, however, educators can design their own programs using a template-based approach that scaffolds both the student and the educator to create their own programs. *Explore15* (see Figure 11) allows students to create their own AL programs on any issue within their local neighborhood while collaborating with other students around the world. The online learning environment walks the user through all nine steps of designing and developing an AL environment.

## Web-Based lessons

There are both benefits and drawbacks to the lessons you can locate on the Internet. The lessons are plentiful, but finding the perfect one for your classroom may be a challenge. With organizations and companies like National Geographic and Verizon stepping into the educational arena, the quality is only getting better. For example, the National Geographic Society has just recently released their new education site entitled National Geographic Education (<http://education.nationalgeographic.com>). Verizon has launched Thinkfinity (<http://www.thinkfinity.org>) that provides lessons for the classroom, at home, and after school, as well as professional development activities. (See Figure 12.) Other sites for lesson plans include:

- » **Internet4Classrooms:** [http://www.internet4classrooms.com/integ\\_tech\\_lessons.htm](http://www.internet4classrooms.com/integ_tech_lessons.htm)
- » **Discovery Education:** <http://school.discoveryeducation.com/lessonplans/tech.html>

**FIGURE 12** Web-Based Lessons: *Thinkfinity*



Source: Verizon Foundation, <http://www.thinkfinity.org>. Reprinted by permission.

- » **EducationWorld:** [http://www.educationworld.com/a\\_tsl/archives/ed\\_tech.shtml](http://www.educationworld.com/a_tsl/archives/ed_tech.shtml)
- » **Hot Chalk:** <http://www.lessonplanspage.com/CIJH.htm>
- » **Merlot:** <http://www.merlot.org>
- » **Microsoft:** <http://www.microsoft.com/education/lessonplans.msp>
- » **Teachnology:** [http://www.teach-nology.com/teachers/lesson\\_plans/computing](http://www.teach-nology.com/teachers/lesson_plans/computing)
- » **The Teachers Corner:** <http://www.theteacherscorner.net/lesson-plans/technology>

For those educators who want to design their own web-based lessons, the **webquest** model (<http://www.webquest.org>) is a good choice. The model, which was developed by Bernie Dodge (1995) at San Diego State University in 1995, has become a staple for allowing users to develop their own web-based lessons. There are many resources that scaffold the designer through the necessary steps.

A webquest comprises a set of explicit principles. A webquest is based on an authentic task that adults complete in a society; uses higher level thinking skills; and also makes use of authentic data on the Internet. A webquest is not a research report or simply an experience that takes place on the web.



## SUMMARY

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

### 1. Introduction to Web-Based Learning Activities: From Lessons to Online Courses

- » Web-based activities have great potential to enhance learning, but they are often time consuming to develop and implement, and difficult to design in ways that have substantial, positive impacts on students' learning. Teachers considering web-based activities should ask themselves several questions before deciding to do an online project.
- » Web-based learning activities that showcase how teachers may employ online resources include: individual lesson plans; online lesson enhancements; completely online courses and curriculum; and all-inclusive online courses, curriculum, and online learning environment.
- » It is important to note that although the design and content of the online resource delineates a planned implementation, it is still up to the teacher to choose the most appropriate pedagogy for the situation. In recent years, the depth and breadth of collaboration has dramatically improved. These "telecollaborations" can be described in three general application categories: interpersonal exchanges, information collection and analysis, and problem solving.
- » Web-based projects are so rich in resources and learning possibilities that they can usually be used with more than one of the following integration strategies: support for student research, practice for information literacy skills, visual learning problems and solutions, development of collaboration skills, and multicultural experiences.
- » Several functions support web-based learning activities. These include: project overview, announcement, and application; tutorial instruction; and information summaries and exchanges.

- » Hundreds of web-based activities are available for teachers to use in their classrooms or join online; some work better than others.

### 2. Developing Web-Based Lessons

- » There are numerous website authoring tools and languages. Some of these tools include *Dreamweaver*, *TeacherWeb*, and *Google Sites*. Some of the languages include: HTML and HTML 5; Java; VRML; PHP and Microsoft ASP.NET; Javascript; and Actionscript.
- » Several of the resources that are useful in both developing and using web pages can be downloaded. They include downloading images such as jpeg and gif formats and downloading programs and plug-ins such as web browsers and pdf readers.
- » When teachers and students engage in distance collaborations, they often need to exchange files of their work. There are numerous ways this can be accomplished, such as an email attachment or using Google Docs, however, the most common way to transfer large documents, graphic files, and programs from one computer to another is called File Transfer Protocol (FTP).
- » Teachers and students can use two different strategies for creating their own web pages and websites: creating pages from scratch using web development software such as Adobe *Dreamweaver* or using one of the many template-based web development tools, such as *TeacherWeb* or *WordPress*.
- » Before an individual begins developing web pages, they should consider these items: limit sharing of personal

information, limit photos and large graphics, address web page criteria, and consider purchasing a domain name.

- » The following steps are recommended as a sequence for web page development: wireframing and/or storyboarding, design and layout, development, testing, publishing, and evaluation and revisions.
- » At a time when everything in the world seems so high tech and highly controlled, the Internet is, in some ways, a wild frontier. While there are oversight agencies that set up and monitor general items such as domain designators, no one controls who posts web pages or the quality of their content.
- » One important way to evaluate a web page is by its design. Teachers and students can use the following characteristics to judge design quality: good structure and organization, clear text and/or graphic links, good visual design, and easy navigation.

### 3. Developing and Implementing Web-Based Programs and Lessons

- » Web-based programs are projects that allow educators to teach an entire unit on a certain topic through an online experience. Although these are not as common as individual lesson plans, they are many times more valuable to educators. Examples of these web-based projects are Adventure Learning projects; Discovery Channel's Education portal; and *GeoThentic*, a program designed for students to learn about science, social studies, and technology.
- » There are both benefits and drawbacks to the lessons you can locate on the Internet. The lessons are plentiful, but finding the perfect one for your classroom may be a challenge. With organizations and companies like National Geographic and Verizon stepping into the educational arena, the quality is only getting better.



## ISSUES

### for Collaborative Discussion and Reflection

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

1. When students spend time online, it is highly likely that they are going to be exposed to unacceptable content. Educators need to be aware of this at all times when they are encouraging students to use the Internet for research. How do you believe educators should be proactive in dealing with this issue?
2. Website development can be very rewarding. However, for those educators who have taught website development to their

students, they have found that it can be time consuming and very tedious for their students, and risks students focusing on technical development rather than the content they are communicating with the website. As an educator, how do you get students to focus on content rather than the technology?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, education-world.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- » Describe the Phase I—Planning activities you would do to use this lesson in your classroom:
  - a. What is the relative advantage of using the technology (ies) in this lesson?
  - b. Reflect on, assess, and describe your Tech-PACK for this situation.
- » Describe the Phase II—Implementation activities you would do to use this lesson in your classroom:
  - a. What are the objectives of the lesson plan?
  - b. How will you assess your students' accomplishment of the objectives?
  - c. What integration strategies are used in this lesson plan?
  - d. How would you prepare the learning environment?
- » Describe the Phase III—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- » Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- » Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Ms. Anderson has been teaching science for ten years. She was recently introduced to web-based programs that allow her to teach numerous science units using real-world and real-time content. Although she is excited about using the web-based programs, her use of technology in the classroom has been limited to using concept mapping on her own computer. Ms. Anderson has been reading a great deal on the program's website, but has not found any strategies to use it in her classroom. At a recent professional development opportunity after school, her colleague showcased how she had been using the various web-based programs, but Ms. Anderson is still very unsure about how best to use these activities.*

- » Deconstruct Ms. Anderson's Tech-PACK in the following way. Fill in the following matrix to show what she knows

and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- » Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

## 5. WHAT'S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- » Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- » Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- » For each of the items in the "What must be learned" column, how would you go about acquiring this knowledge?
- » Envision and describe the ideal classroom context for teaching your topic using the identified technology.



**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.



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# TEACHING AND LEARNING WITH TECHNOLOGY IN ENGLISH AND LANGUAGE ARTS INSTRUCTION

# TEACHING AND LEARNING WITH TECHNOLOGY IN ENGLISH AND LANGUAGE ARTS INSTRUCTION

To become fully literate in today's world, students must become proficient in the new literacies of 21st-century technologies. Therefore, literacy educators have a responsibility to integrate these technologies effectively into the literacy curriculum in order to prepare students for the literacy future they deserve.

Position statement of the International Reading Association (2009, p. 1)

## o u t c o m e s

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

1. Recognize the implications for technology integration of each current issue faced by English and language arts teachers,
2. Create key strategies for integrating technology into the English and language arts curricula.
3. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to English and language arts.



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## key terms

autocorrect  
blog  
digital literacy  
information literacy

new literacies  
QWERTY keyboard  
talking word  
processors

track changes  
vlog  
wiki



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## TECHNOLOGY INTEGRATION IN ACTION: MY SIDE OF THE STORY: TEACHING DIGITAL LITERACIES WITH A MULTIMEDIA STORYTELLING PROJECT

GRADE LEVELS: 6–8 • CONTENT AREA/TOPIC: English/language arts, literature, creative writing •  
LENGTH OF TIME: Three weeks

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

Mr. Caruso is a seventh grade teacher who teaches literature and composition. He had been reading about the new “digital literacies” that required skills in using many different media to communicate information in a variety of ways, in addition to print. He also thought this might be a good way to confront a perennial problem he had with teaching literature: getting students to connect more with characters in stories by analyzing their traits, motivations, conflicts, points of view, and relationships with others. He felt character analysis was one of the most powerful and instructive aspects of literature, since it teaches students about why they and others act as they do in various situations and how different people can view the same situation in very different ways. The project he had in mind would ask students to choose a character in a popular story and create a different telling of

the story from the point of view of that character. This approach would require his students to analyze the characters more closely and use narration and images they select to illustrate the “new and improved” version they create. He had also been using blogs to encourage students’ journaling, and he liked the idea of posting all the stories online and using blogs to allow students to critique each other’s work. This would give them an audience for their stories other than himself, which he felt would be very motivating.

#### Step 2: Assess Tech-PACK.

**Content and Pedagogical Domains.** Mr. Caruso had been teaching literature and composition at the junior high level for about five years. In his spare time, he worked on his own writing and had hopes of becoming a published author of stories for adolescents and young adults. He was working on a master’s degree in English education and sometimes used his college course assignments to try out new materials and strategies in his classroom. With each new strategy that worked well, he felt more confident in his ability to help his students become more effective



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readers and writers. However, he still felt challenged to find better ways of reaching students who viewed literature as uninteresting and irrelevant to their lives.

**Technology Domain.** As a result of his graduate English methods courses, Mr. Caruso had become an avid technology user. He already used *PowerPoint* presentations and blogging in his classroom, and made sure his students learned word processing so they could use it for all their assignments. However, he knew little about the narration and interactive-button features of the *PowerPoint* software, which students would need in order to create their multimedia stories.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Mr. Caruso knew that his unit had to be tied to state and national language arts standards, so he identified those he wanted to help achieve with this project. Since he wanted to make sure

students really achieved what he had in mind, he identified the following project outcomes, objectives, and assessments:

- » **Outcome:** Create a multimedia presentation that takes a different perspective on a popular story. **Objective:** At least 90% of students will achieve an 80% or better rubric score on a multimedia project designed to tell a popular story from the perspective of one of the characters. **Assessment:** Rubric to assess the quality of character analysis, narration, and images in the project.
- » **Outcome:** Make blog posts that reflect good character analysis. **Objective:** At least 90% of students will post at least five comments, including at least one that reflects insights on a character in the original or revised versions of the story. **Assessment:** Checklist of requirements for blog posts.

### Step 4: Design integration strategies.

Mr. Caruso designed the following sequence of daily activities for the three-week project.

- » **Days 1-2: Introduce the unit.** The teacher introduces the project by having students read and discuss *The True Story of the Three Little Pigs* by Jon Scieszka, which tells the traditional fairy tale through the wolf's eyes. The teacher leads a discussion on character traits and motivations reflected in the story and how this influences the narrative and plot. Then the teacher asks students to analyze another story that is currently popular with young people of their age. Again, they discuss how one of the characters might tell the same story from a different perspective. Finally, the teacher introduces the project and hands out and discusses the assessment rubric.
- » **Days 3-4: Library work and individual meetings.** The teacher takes students to the library-media center to review books and stories he has selected. He asks them to select a story for their project focus from a set he has identified; or they may identify one of their own choosing. As the students

## ISSUES AND PROBLEMS IN ENGLISH AND LANGUAGE ARTS

Reading, writing, and critically analyzing written communications are considered fundamental skills for a literate person, and technologies have much to offer teachers as they help their students develop these skills. However, technologies have also brought about dramatic changes in the format and types of communications that literate people must deal with, thus presenting an array of new challenges to English and language arts teachers. This section discusses the types of issues teachers of English and language arts must confront

when teaching literacy skills and with integrating technology into literacy topics.

### Teachers' Responsibilities for the "New Literacies"

The definition of literacy has changed dramatically in the United States over the course of its history, from being able to sign your name, to being familiar with certain canonical texts, to being able to read and write and make meaning from the written word, to being proficient in 21st century skills that are context specific. Beach and Swiss (2011) and

are ready to identify selections, he meets with them and confirms that their idea will work for the project.

- » **Day 5: Demonstration of PowerPoint template and copyright discussion.** Using a template designed for the project, the teacher shows students the interactive and narration features they will use and shows how to “grab” images from the Internet and insert them into their presentation. He discussed copyright and how to credit copyrighted works they use in their projects.
- » **Days 6–10: Individual student work on projects.** Students work on classroom computers to create their projects. The teacher circulates around to each student, answering questions and offering assistance and suggestions.
- » **Days 11–14: Project posting and blogging.** As students complete their projects, they upload them to the school server. All students review all story presentations and select at least five on which to post comments and suggestions. Students may revise their projects as they read the comments.
- » **Day 15: Project review and discussion.** The teacher leads a wrap-up discussion on what the students learned about character analysis from the project and how they might look at stories differently in the future. He asks students to vote on a “best-of-class” project to be placed on the school website for special recognition.

### Step 5: Prepare instructional environment.

Mr. Caruso did the following tasks to prepare for the project:

- » **Select stories for student review:** He reviewed a variety of stories students might like to use for their project and asked the librarian to make copies available on the days students needed them.
- » **Schedule library:** He scheduled the library for a two-day period and asked the library-media center director to be available to assist his students.

» **Computer preparation:** He made sure the PowerPoint software was available and working on each of his classroom computers and set up a special blog area for this project.

» **Prepare assessments:** He created a rubric for grading the assignments and a checklist for reviewing blog posts.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

As Mr. Caruso reviewed the rubric scores, he was happy to see he had met his objectives for the project. All but two students achieved a score of 80% or better. Most points were lost on criteria related to image use and copyright. As usual, students were most enthusiastic about blogging. Every student had commented on more than the required five projects, and each had posted at least one comment that reflected good insights about character portrayals. He knew he was on the right track with the project.

### Step 7: Make revisions.

Based on results from the projects, Mr. Caruso knew he would have to spend more time teaching students about effective and legal use of images. He decided to provide some good and bad examples of image use from the projects submitted by this group of students. He had also encountered an unexpected problem when students wanted to record narrations. The noise level in the classroom did not allow good, clear recordings, and he had to allow students to record in other rooms. He planned to provide for this ahead of time the next time he taught this unit.

**Source:** Based on a concept from the Hot Chalk Lesson Plans Page lesson, “What Really Did Happen?” at: <http://www.lessonplanspage.com/CIJH.htm>.

Wohlwend and Lewis (2011) point out that as new technologies emerge, so does the need for new literacies. Two of these **new literacies** are digital literacy and information literacy.

**Digital literacy.** New technologies introduced in the era of the Internet have expanded the definition of literacy to include proficiency not only with texts in many different formats but also with the devices that store them. Some authors refer to this new and ever-changing set of skills as “new literacies” or “media literacy.” Others refer to these skills under a more inclusive term: **digital literacy**. Originally, digital literacy meant the ability to use computer devices and

software to locate and use information. However, like the definition of literacy itself, the definition of digital literacy has changed over the years and now means skills in using the information that technological devices carry, in addition to skills in using the devices themselves. Stripling (2010) says digital literacy means that “Students must be able to gather information from any format and, more importantly, make sense of that information, use it, and communicate it to others” (p. 16). Jewett (2011) further says that, “Literacies based on digital technologies expand the dominant views of literacy” (p. 342). She says that the new definition of literacy includes many modes of communication mediated by new technologies. But even these current definitions are fluid.

Bomer, Zok, David, and Ok (2010) remind us that “in the time since it emerged, our definition of ‘new’ literacies has evolved and shifted. . . . They will shift again” (p. 9).

Then-International Reading Association (IRA) President Patricia Edwards (2010) pointed out that, “If students are to successfully meet the social, political, and economic demands of their futures, they must be able to adapt and reinvent the ways that they read and write the world” (p. 22). Information now comes to students via email and ebooks; web pages and podcasts; blogs, vlogs, and wikis; instant messages and Twitter feeds; and movies and streaming video. A **blog** is a combination of the words “web log” and refers to a web page that serves as a publicly accessible location for discussing a topic or issue. Blogs began as personal journals, but their use rapidly expanded to a public discussion forum in which anyone could post opinions on the topic. A **vlog**, a combination of video and blog is a video version of the blog in which posts are video clips instead of text entries. A **wiki**, on the other hand, is a collection of web pages located in an online community that encourages collaboration and communication of ideas by having users contribute or modify content. Thus, wikis contain the ongoing work of many authors. Digital literacy now encompasses skills in using each of these formats. Since teaching students to make meaning from texts is primarily seen as the responsibility of English and language arts teachers, these shifting definitions challenge teachers to constantly rethink the skills they teach in order to make their 21st century students truly literate. Edwards (2010) reminds us that, “Teachers have to reconceptualize their definitions of literacy” (p. 22). Beach and Swiss (2011) confirm that literacy is increasingly a multi-modal concept, as students combine writing, images, and music soundtracks to create representations of their personal experiences in vlogs and digital stories. They also feel that English and language arts teachers can use vlogs and digital video production in the classroom to help students develop important communication and critical inquiry skills.

**Information literacy.** According to the American Library Association (ALA) (2000), **information literacy** is “a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (p. 2). Information literacy is a required set of skills when students do background research for projects or reports. Though research skills are essential to good work on students’ projects and reports, Artman, Frisicaro-Pawłowski, and Monge (2010) find that the most common way of teaching these skills is with a “one-shot” library session. That is, students attend only one, usually brief training session. Jonker (2011) notes that though online resources can be “worth (their) weight in golden encyclopedias” (p. 72), to school students, their online research is often limited to what Jonker memorably

calls “the research equivalent of a Hail Mary pass, a Google search—a gambit that’s frequently inefficient and inaccurate” (p. 72). Artman et al. (2010) say that “composition instructors commonly bear responsibility for general research instruction, helping students to take advantage of such resources—and to use them creatively, purposefully, and thoughtfully” (p. 94). Thus, English and language arts teachers can add yet another literacy responsibility to their already-considerable instructional load.

## The Need for New Instructional Strategies

Standard 8 of the National Council of Teachers of English (NCTE) and IRA Standards for the English Language Arts (1996; see Figure 1), emphasizes the importance of students using technology in their learning: “Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge” (p. 39). The new literacies require a high level of critical sophistication from our students, and it is only through instruction and experiences with new technologies that they will develop these skills. However, teaching students to use new technologies calls for an array of new instructional strategies.

### New strategies to foster reading and writing skills.

Larson (2010) describes how ebook and ereader reading behaviors differ from behaviors with print text. Students can make notes and comments directly on what they are reading, which helps them better comprehend its meaning. They can also adjust font size, access a built-in dictionary to examine word meanings and pronunciations, and use a text-to-speech feature to listen to or re-read passages they find difficult. Dalton and Grisham (2011) discuss ten new strategies to build vocabulary skills using new technologies. One of these strategies calls for students to use *Wordle* (<http://www.wordle.net>) to create a “word cloud” based on the frequency of words used in a text (see an example in Figure 2). Sweeney (2010) offers strategies for using Internet resources, online forums, word processing, and other technologies to support writing instruction.

**Strategies requiring social interaction.** New forms of literacy are much more contingent on social interactions with others than traditional literacies. According to the Standards for the English Language Arts (1996), teachers should begin “giving students the enjoyment and pride of sometimes being their teachers’ teachers” (p. 40). Technology offers a natural setting in which students can be positioned as the experts, helping redefine the student–teacher relationship. The new forms of literacy and students

## FIGURE 1 NCTE/IRA Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
2. Students read a wide range of literature from many periods in many genres to build an understanding of the many dimensions (e.g., philosophical, ethical, aesthetic) of human experience.
3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).
4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
9. Students develop an understanding of and respect for diversity in language use, patterns, and dialects across cultures, ethnic groups, geographic regions, and social roles.
10. Students whose first language is not English make use of their first language to develop competency in the English language arts and to develop understanding of content across the curriculum.
11. Students participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.
12. Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Source: *Standards for the English Language Arts*, by the International Reading Association and the National Council of Teachers of English, copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

## FIGURE 2 Example Word Cloud Created with Wordle



Source: Word cloud created from Sonnet #43 from *Sonnets from the Portuguese* by Elizabeth Barrett Browning. Wordle created at <http://www.wordle.net>.

becoming experts illustrate the power of people working together and are grounded in the social constructivist theory proposed by Vygotsky (Davydov, 1995), which asserts that learning occurs through interactions with others.

Another reason that new literacies demand a more social environment is that teaching and learning are no longer confined to a traditional classroom context. Today, thanks to the Internet, the classroom is a worldwide location in which networked technologies for literacy enable us to communicate with people anywhere. We transmit and receive information in various formats and from many different people. These interactions provide a tremendous multicultural benefit to our classrooms that has never existed before. One strategy that makes use of this new social environment is having students share their work products with the world by publishing them online in blogs, wikis, and web pages. Another strategy calls for students to comment on each other's posted works, thus



engaging in a collaboration that makes them part of an ever-growing and changing community of learners.

## Challenges of Working with Diverse Learners

Schools have more diverse student populations today than ever before. This cultural and linguistic diversity creates classrooms that are richer yet more complex. Although we value and celebrate the opportunity to interact with students of different nationalities, races, and ethnicities, this creates new challenges for English and language arts teachers. This is especially true when working with students who are learning English as a second or third language. It is also true when working with struggling readers. Often when students experience literacy problems at a young age, they continue to have reading difficulties throughout their schooling. Students who typically experience this problem include children who begin school without a solid literacy foundation, learn English as a second language, live in literacy-impaired homes, have attention deficit/hyperactivity disorder,

or do not receive appropriate instruction in school. Because many students need additional instruction in literacy, appropriate use of technology (e.g., audio books and ebooks, websites, and software) can support their growth.

## Challenges of Motivating Students to Read and Write

The more students read, the better developed their language and writing skills become. However, teachers find it an ongoing challenge to motivate students to read—either for study or for pleasure. Indeed, students rarely choose reading as a free-time activity. Teachers are turning to the interactive and visual qualities of software and websites to increase motivation for reading and writing. The Adapting for Special Needs feature provides information on how to support students who struggle with reading and writing.

Teachers also find it an ongoing challenge to motivate students to express themselves in writing. Students especially resist the labor involved in revising research papers and compositions. In addition to word processing, which has been in use for many



## ADAPTING FOR SPECIAL NEEDS

### Reading and Writing Tools

**For writing:** Students with disabilities may struggle in many English and Language Arts classrooms because of the emphasis on reading and writing skills; these are common deficit areas for many students with disabilities. As a result, it is important to consider how technology might be used to scaffold and support each student's literacy development. One common approach for supporting diverse learners is to provide a specialized word processor specially designed with features that support poor writers. These include:

- » *Clicker5* (<http://www.cricksoft.com/uk/products/tools/clicker>)—Word processor with point-and-click access to whole words, phrases, and pictures to insert into writing.
- » *Co:Writer* (<http://www.donjohnston.com/products/cowriter/index.html>)—Word prediction software that assists a user during word processing by “predicting” and inserting a word the user intends to type.
- » *PixWriter* (<http://www.slatersoftware.com/pixwriter.html>)—Program that assists writing by allowing users to select text from pictured buttons.
- » *Read, Write Gold* (<http://www.texthelp.com>)—A program with a toolbar that integrates with applications such as Microsoft *Word*, allowing students to access support tools that highlight and read aloud text from within these programs.

Another tactic is to compensate for poor writing and spelling skills by changing the writing production task from written drafting to dictation. Several tools are available that alter the nature of the text generation process and allow students to move into the revision phase of writing.

- » *Dragon Speech Recognition Software* (software and mobile app) (<http://www.nuance.com/dragon/index.htm>)—This software can be trained to recognize one's voice.
- » *iDictate* (<http://www.idictate.com>) and *Speak-Write* (<http://www.speak-write.com/web>)—These are transcription services that accept voice recordings and email a text transcription.

**For reading:** When students struggle to read grade level content independently and fluently, text to speech products may be useful to allow students to listen to the information. They use these tools to play back any given text selection in a spoken voice. Free text-to-speech tools include the following:

- » *Vozme* (<http://www.vozme.com>)
- » *NaturalReader* (<http://www.naturalreaders.com/index.htm>)

Contributed by Dave Edyburn

years, a variety of technology tools and strategies have emerged to spur students' desire to write, to improve the quality of their written products (e.g., email projects, blogs), and to provide authentic publication sources. According to the Standards for the English Language Arts (1996), technology not only enhances students' motivation to write, but also encourages them to assume greater responsibility for their learning.

## Teachers' Growth as Literacy Professionals and Leaders

The position statement published by the International Reading Association (2009) clearly states what literacy teachers need to know about integrating technology into the curriculum. According to the IRA, students have the right to have:

- » Teachers who use Information and Communication Technologies (ICTs) skillfully for teaching and learning
- » Peers who use ICTs responsibly and who share their knowledge
- » A literacy curriculum that offers opportunities for collaboration with peers around the world
- » Instruction that embeds critical and culturally sensitive thinking into practice
- » Standards and assessments that include new literacies
- » Leaders and policymakers who are committed advocates of ICTs for teaching and learning
- » Equal access to ICTs

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Couros (2006) offers a diagram that illustrates a modern, "networked" teacher connected with the many technological tools that are helping to define today's digital literacy (see Figure 3). Obviously, these visions will not be fully realized unless teachers receive continued and systematic professional development. Thus, the burden falls on teachers' shoulders to take responsibility for learning how to integrate technologies effectively into the curriculum. Teachers are expanding their own professional growth through school/university partnership projects and use of online resources for professional development, and increased access to and participation in professional organizations such as the International Reading Association (IRA) and the National Council for Teachers of English (NCTE).

As Wohlwend (2010) notes, "Ironically, in a time of massive global technological innovation in which new literacies are popping up almost daily, U.S. schools are clamping down rather than ramping up" (p. 144). Teachers who are in tune with the need for a revised definition of literacies can lead the way for new policies in schools, policies that embrace technologies, rather than fear them.

**FIGURE 3** Couros (2006) The Networked Teacher



Source: The Networked Teacher Diagram by Dr. Alec Couros. Reprinted by permission.

## QWERTY Keyboarding: To Teach or Not to Teach?

The most common way to write using a computer requires input through a regular **QWERTY keyboard**, so named because of the first six letters in the top letter line of a typewriter keyboard. There is an ongoing discussion of whether we should teach keyboarding instruction as a prerequisite to the use of computers for writing. Those in favor argue that students will learn bad habits if they use the keyboard without proper training, that these bad habits might become permanent, and that failure to learn proper fingering will inhibit fluent and speedy keyboarding. Those against requiring keyboarding instruction as a prerequisite argue that too much student time and computer resources are spent on getting students trained to type quickly, that students need only basic keyboard familiarization, and that keyboarding instruction would likely be a waste of time unless students have real-world applications in which to use the computer. Both arguments are legitimate, and most teachers have resolved the issue, at least temporarily, by favoring keyboarding instruction if it is available and needed but not preventing students from using the computer if they do not yet have good keyboarding skills.

## The Cursive Writing Controversy

An issue that is related to questions about keyboarding is whether time spent teaching cursive writing would be better spent on other educational priorities. Critics of this long-taught skill argue that it is no longer used enough to justify

## SHOULD WORD PROCESSING REPLACE CURSIVE WRITING?

Take a position for or against (based either on your own position or one assigned to you) 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 light of the increasing use of word processing in school learning, higher education, and the workplace, some people feel that elementary school time learning cursive writing is not well spent. Others feel that many benefits remain

for teaching cursive writing. (See a discussion of the debate in the *New York Times* (<http://www.nytimes.com>) article, "The Case for Cursive.") In light of the switch to typed writing at about grade 6, would time spent teaching cursive writing in elementary school be better spent teaching keyboarding and word processing software functions? (See the article, "Cursive Handwriting Getting Erased as Schools Teach Typing Over Script," at the Parent Dish website <http://www.parentdish.com>, and "Time to Write Off Cursive?" at the *Athens Banner-Herald* website <http://onlineathens.com>.) What evidence can you present that cursive writing does or does not deserve a prominent place in 21st century elementary school curriculum? What would be the impact on school students if these skills were to be replaced by instruction in word processing?

its place in the elementary school curriculum. Some feel that this time would be better spent teaching writing with word processing. Supporters of cursive writing instruction point to its effect on shaping fine motor skills, its use in legal matters, and the need to be able to read historical handwritten documents. Read more about this issue in the Hot Topics for Debate feature.

## TECHNOLOGY INTEGRATION STRATEGIES FOR ENGLISH AND LANGUAGE ARTS

Thanks in part to strong support for technologies by professional organizations such as the International Reading Association (2009) and the National Council of Teachers of English, the last decade has seen a growing emphasis on the use of technologies to support literacy instruction. This section focuses on integration strategies that support the following four English and language arts areas: word fluency and vocabulary development; comprehension and literacy development; the teaching of writing; and learning about literature. Strategies and resources under these four headings are summarized in Table 1. See also the accompanying Top Ten feature for additional strategies.

### Support for Word Fluency and Vocabulary Development

Literacy begins at the word level, with fluency in decoding, reading, and understanding individual words. Several technology-enhanced strategies support student growth in these skills, including practice in matching letters and sounds, matching words with meanings, and vocabulary growth. Many strategies described here can be implemented with free websites, only a few of which are mentioned here as examples.

#### Online practice in matching letters and sounds.

Phonemic awareness remains a foundational skill in learning to read, and many websites provide interactive practice in these important skills. For example, the ReadWriteThink website maintained by the IRA and NCTE offers a number of matching-letters-to-sounds exercises like the one shown in Figure 4. To make this practice more accessible to children outside of school, apps are available with this focus. The word app is short for application and the term usually refers to any Internet application specifically designed to run on mobile devices such as smart phones. Apps for iPhones and iPads can be downloaded from the education apps area of the Apple website, and apps for the Android phones may be downloaded from numerous sites. See example apps to support English and language arts in the Mobile Apps for Education feature.

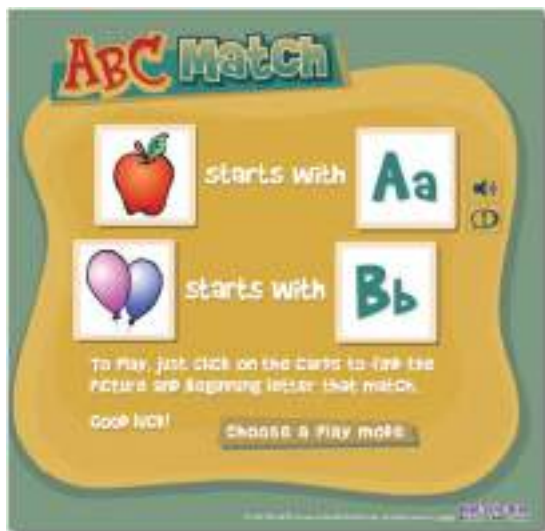
**TABLE 1 Summary of Technology Integration Strategies for English and Language Arts**

Technology Integration Strategies	Benefits	Sample Resources and Activities
<b>Support for Word Fluency and Vocabulary Development</b>		
Online practice in matching letters and sounds	Offers motivating environment for practice	IRA website: <a href="http://www.readwritethink.org">http://www.readwritethink.org</a>
Online practice in matching words and meanings	Offers motivating environment for practice	<i>Brainpop</i> : <a href="http://www.brainpop.com">http://www.brainpop.com</a>
Online tools to engage students in vocabulary learning	Offers motivating environment for engaging students with words	<i>Wordle</i> : <a href="http://www.wordle.net">http://www.wordle.net</a> <i>Wordsift</i> : <a href="http://www.wordsift.com">http://www.wordsift.com</a> Thesaurus: <a href="http://www.visualthesaurus.com">http://www.visualthesaurus.com</a>
<b>Support for Comprehension and Literacy Development</b>		
Using digital text to encourage engaged reading	Allows more flexibility to interact with text; scaffolds emerging reading skills	Ebooks Interactive stories
Supported reading with software and portable assistive devices	Devices and software read words aloud to students; especially helps struggling students	Talking word processors such as <i>Write: OutLoud</i> (Don Johnston, Inc., <a href="http://www.donjohnston.com">http://www.donjohnston.com</a> ) or <i>Kurzweil 300</i> ( <a href="http://www.kurzweilededu.com">http://www.kurzweilededu.com</a> ) Handheld devices
Digital storytelling	Engages students with language; supports digital literacy	Center for Digital Storytelling: <a href="http://www.storycenter.org">http://www.storycenter.org</a>
<b>Support for Writing Instruction</b>		
Strategies for preparing to write (pre-writing)	Helps students organize their thoughts prior to writing	Electronic outlining Concept mapping
Strategies to encourage writing	Provides environments for modeling, supporting good writing	Websites such as the Academy of American Poets at <a href="http://www.poets.org">http://www.poets.org</a> and <a href="http://www.thewritesource.com/studentmodels">http://www.thewritesource.com/studentmodels</a> Story starters Blogs and wikis
Using word processing to produce written drafts	Offers more flexibility to revise while writing	Various word processing software packages (e.g., Microsoft <i>Word</i> )
Modeling to support revising and editing written drafts	Provides environments for modeling editing process and offers more editing flexibility	Interactive whiteboards Word processing features: spell-checkers and grammar checkers
Providing feedback with grammar, spell-check, and thesaurus features	Provides visual, immediate support and feedback during revision of drafts	Word processing features: grammar, spell-check, and thesaurus features
Providing feedback on student writing with editing tools	Provides supportive environment for demonstrating revision needs	Word processing features: autocorrect and track changes features
Digital publishing of student work	Gives students an authentic purpose, audience for their written works	ePALS Global Community: <a href="http://www.epals.com">http://www.epals.com</a> KidPub: <a href="http://www.kidpub.com">http://www.kidpub.com</a> Bookworm: <a href="http://www.bookworm-mag.com">http://www.bookworm-mag.com</a> WriteKids: <a href="http://writekids.tripod.com">http://writekids.tripod.com</a> Your Student News: <a href="http://www.yourstudentnews.com">http://www.yourstudentnews.com</a>

Continued

**TABLE 1** Summary of Technology Integration Strategies for English and Language Arts (continued)

Support for Literature Learning		
Accessing online free copies of published works	Offers students free access to reading materials	The Bible Gateway: <a href="http://www.biblegateway.com">http://www.biblegateway.com</a> Google Books Online: <a href="http://books.google.com">http://books.google.com</a> The Literature Page: <a href="http://www.literaturepage.com">http://www.literaturepage.com</a> The Literature Network: <a href="http://www.online-literature.com">http://www.online-literature.com</a> Project Gutenberg: <a href="http://www.gutenberg.org">http://www.gutenberg.org</a> Poets.org: <a href="http://www.poets.org">http://www.poets.org</a> Qur'an: <a href="http://quran.com">http://quran.com</a> Shakespeare Online: <a href="http://www.shakespeare-online.com">http://www.shakespeare-online.com</a>
Accessing online background information on authors	Offers quick access to a wealth of information on authors	Famous People: <a href="http://www.famouspeople.co.uk">http://www.famouspeople.co.uk</a> Poets.org: <a href="http://www.poets.org/">http://www.poets.org/</a> Biblio: <a href="http://www.biblio.com/authors.php">http://www.biblio.com/authors.php</a>
Support for literary analysis	Allows visual demonstrations, interactions to support analysis activities	Interactive whiteboards Ereaders

**FIGURE 4** Sample ReadWriteThink.org Letter-Sound Exercise

Source: ReadWriteThink.org is a nonprofit website maintained by the International Reading Association and the National Council of Teacher and English, with support from the Verizon Foundation. We publish free lesson plans, interactive student materials, Web resources, and standards for classroom teachers of reading and the English language arts. Reprinted by permission.

**Online practice in matching words with meanings.** As Glenberg, Goldberg, and Zhu (2011) remind us, many children, especially those learning English as a second or third language, can learn to sound out words, but without visual

prompts, they may not connect these words to images from their own experience. Websites such as *Brainpop* (<http://www.brainpop.com>) are among those that offer exercises to give students practice in linking words and images so that emerging readers and new English language learners can begin to make those associations. See an example *Brainpop* exercise in Figure 5.

#### Online tools to engage students in vocabulary learning.

A growing number of innovative and fun sites are available for encouraging vocabulary growth. Dalton and Grisham (2011) offer some specific examples, such as *Wordle* (<http://www.wordle.net>), *Wordsift* (<http://www.wordsift.com>), and *Visual Thesaurus* (<http://www.visualthesaurus.com>), but there are numerous others. These sites are diverse in their approaches but all serve to engage students with words in motivating ways.

## Support for Comprehension and Literacy Development

Technologies offer a variety of ways to support both traditional reading comprehension and emerging literacies. Those described in this section include encouraging engaged reading with digital text, supporting reading with portable assistive devices, and digital storytelling.

#### Using digital text to encourage engaged reading.

Ebooks and interactive stories in either online or disc format serve to engage readers by allowing them to notate and



Take advantage of these ten powerful strategies for using technology to enhance the teaching of reading, writing, and language skills and literature learning.


SOURCE	TRACK	SELECTION
Digital publishing of students' work to encourage writing	1	Students spend more time on their writing when they know their work will be displayed on a website or presentation that others will see.
Blogs and wikis to encourage student writing	2	When their posts become "dynamic sites for conversation" (Bromley, 2010, p. 100), students become more engaged in writing.
Modeling effective revising and editing processes with whiteboards	3	Projecting a student's typed draft onto a screen or whiteboard allows teachers to model more clearly the thinking and decision making that goes into analyzing and revising text.
Concept mapping software to help students plan their writing	4	Concept mapping software (e.g., <i>Inspiration</i> ) helps students create visual outlines to plan what they want to write about.
Using word processing features such as track changes and autocorrect to aid editing	5	Teachers' editing of student papers is more efficient and students get more visual feedback on their writing.
Digital text to encourage engaged reading	6	Interactive storybooks or ebooks scaffold students' initial reading skills and draw them into reading activities.
Using ereaders for literary analysis	7	With text on an ereader device, students can more easily do searches and count instances of words or phrases that indicate mood or metaphor.
Use talking word processors and handheld devices to provide audio support for reading	8	Access to audio pronunciation and definitions scaffolds reading processes for students having difficulties learning to read.
Modeling literary analysis with whiteboards	9	Analysis of literary works becomes more engaging when students interact with text in a visual, hands-on environment.
Accessing online texts and information about authors	10	Copies of many materials are free online and websites offer rich sources of information about authors and their works.





# MOBILE APPS FOR EDUCATION

## ENGLISH AND LANGUAGE ARTS

App Name	Description	Device
ABC Writing Zoo Animals Game HD  By Brain Counts	Learn ABC reading, writing, and listening skills with zoo animals. This game reinforces associative learning, which may aid in early brain development in young kids and may help children get a head start in reading and writing.	iPad

Source: App image reprinted by permission of Brain Counts.

### FIGURE 5 Brainpop Practice in Matching Words and Images



Source: <http://www.brainpop.com>. © BrainPOP. All rights reserved. Reprinted by permission.

interact with digital versions of text as they read. In their review of research on using computer-assisted methods to support learning for struggling readers, Stetter and Hughes (2010) found that “It is supported text such as e-books and hypermedia that have resulted in the greatest gains for students with and without learning disabilities” (p. 9). Ebooks and interactive versions of stories, especially those that offer audible reading on demand, offer students scaffolds for their emerging reading skills.

### FIGURE 6 ReadingPen®2 by Wizcom



Source: Reprinted by permission of WizCom Technologies Inc

**Supported reading with software and portable assistive devices.** To aid student reading, software is available to read passages aloud and handheld devices are available to give definitions or to pronounce unfamiliar words aloud. These materials are particularly useful for students with reading difficulties or those for whom English is not a first language. See Figure 6 for an example of a handheld device. The device “reads” the word as the student points to it. Some devices give a printed definition on the small screen; others offer audio pronunciation. Still others are available to translate words to other languages. **Talking word processors** are software packages that read typed words aloud. They have proven especially useful for students with disabilities. Two examples of these are *Write: OutLoud* from Don Johnston, Inc., and the *Kurzweil 300* (see Table 1 for URLs).

**Digital storytelling.** Digital storytelling is the process of using images and audio to tell the stories of lives, events, or eras. According to the Center for Digital Storytelling (<http://www.storycenter.org>), a digital story is “a short, first person video-narrative created by combining recorded voice, still and moving images, and music or other sounds.” Thesen and Kira-Soteriou (2011) and Rule (2011) are among many teachers who advocate using digital storytelling with students in order to enrich their literacy development. Thesen and Kira-Soteriou (2011) also offered detailed advice on how to implement this strategy in a

## TECHNOLOGY INTEGRATION EXAMPLE 1

### DIGITAL STORYTELLING

**TITLE:** Important Moments: A Narration

**CONTENT AREA/TOPIC:** Language arts, digital literacy

**GRADE LEVEL:** 2

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** English; Communication and Collaboration: Communicate clearly; Creativity and Innovation: Work creatively with others; ICT Literacy: Apply technology effectively

**DESCRIPTION:** Students begin by viewing digital stories previously produced by other children and learning the elements of telling a story. After an introduction to the software they will use (*PhotoStory 3*), students choose a moment in their lives that was significant to them and write a short narrative about it. They learn how to put expression in their voices to convey emotions. They work with a partner to review their written narratives and give each other feedback. They record the narration, learning how to use tempo, rate, and silences. Finally, they put their stories together and create drawings to illustrate them. The movies “premier” in the classroom, complete with popcorn, and the teacher gives each student a disc of the stories to take home.

**Source:** Based on concepts from Thesen, A., & Kira-Soteriou, J. (2011). “Using digital storytelling to unlock student potential.” *New England Reading Association Journal*, 46(2), 93–101.

classroom. Further information and professional development opportunities are available at the Center for Digital Storytelling site. Also, see the Technology Integration Example 1 based on the approach described by Thesen and Kira-Soteriou (2011).

### Support for Writing Instruction

Word processing programs and other technologies offer unique capabilities to help writers prepare to write and to improve the quality of their written work. Strategies are described here for each phase in the writing process, including preparing to write (pre-writing); drafting, revising, and editing; and publishing student work.

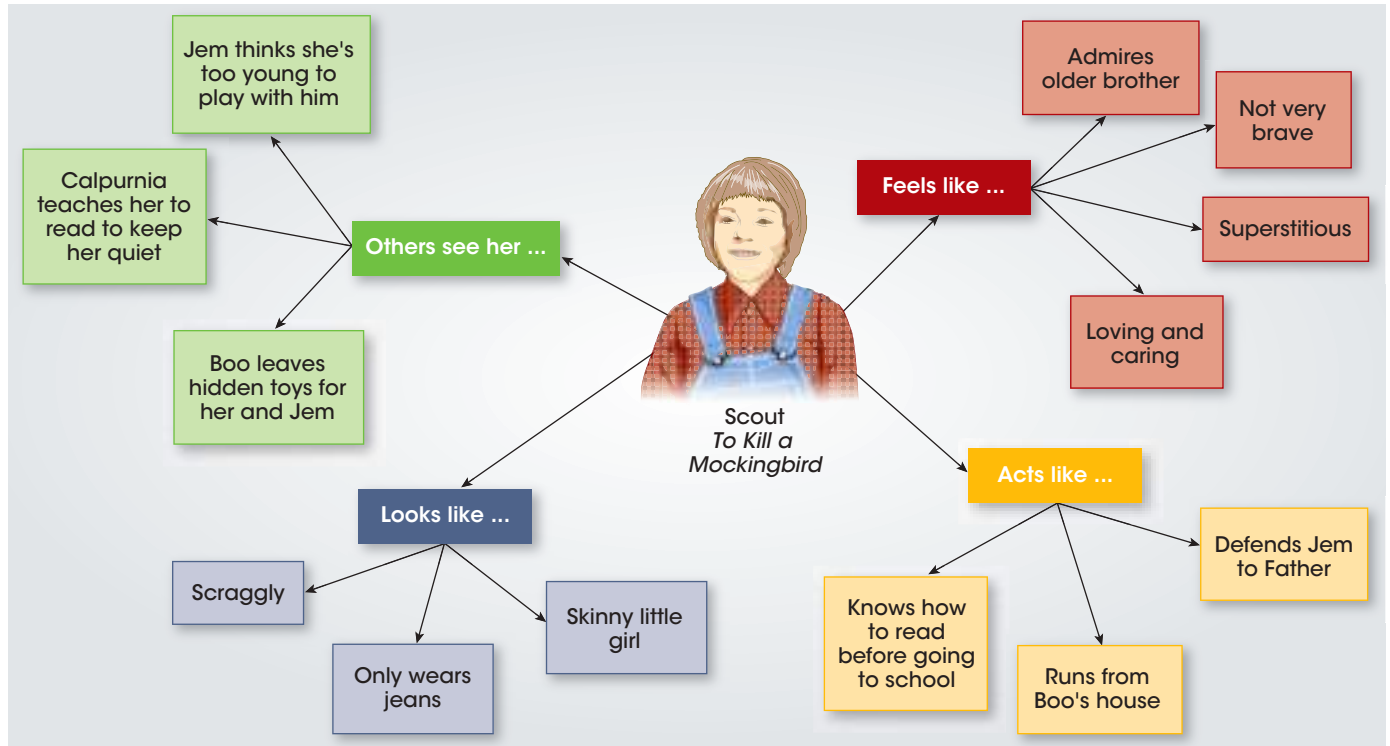
**Strategies for preparing to write (pre-writing).** Getting started is often one of the most difficult aspects of writing,

and young writers find it particularly onerous. During the pre-writing stage, teachers communicate to students the format, audience, topic, purpose, and assessment method for the writing assignment. During this stage, students need to organize their thoughts graphically. For instance, if students are writing a fictional story, they need to brainstorm ideas for the story line, setting, and major characters; refine and organize those ideas; and generate a plan for presenting each story element in an intriguing manner. If the assignment is to write a report, then students need to gather information on the topic from a variety of sources; synthesize and arrange this information into categories or subtopics; and generate a plan for presenting the information in a logical way. All types of pre-writing activities can be facilitated by using information organizing software, such as electronic outlining and concept mapping programs, and various strategies to encourage student writing.

- » **Electronic outlining**—Electronic outlining is now integrated into almost all major word processing programs and is easily accessible as a planning tool. Electronic outliners automatically generate headings and subheadings from typed information. The advantages to using them are that new headings/subheadings can be easily inserted anywhere in the outline, headings/subheadings can be shifted around quickly to reflect a student’s thinking and planning, and the prefixes serving as organizational clues are automatically changed to reflect revisions to the outline’s organization.
- » **Concept mapping**—Concept mapping software is popular as a pre-writing planning tool—it allows students to produce an outline as a visual map (see Figure 7). The most popular concept mapping programs are *Kidspiration* for grades K–3 and *Inspiration* for grades 4 and above (Inspiration Software, Inc.); both products have electronic tools for both outlining and diagramming. The diagramming side of the program can be used to create a variety of graphic displays, all of which are useful for students who like to think and plan using visual representations of their ideas. For example, students can easily brainstorm a cluster map of ideas for a story and then rearrange or expand on the ideas for later development. Students can also use the program to generate a hierarchical map of key concepts to be explored for a research paper and link those concepts with labels that demonstrate their conceptual relationship.

**Strategies to encourage writing.** It is critical that teachers both model the type of writing expected and provide environments that motivate students to write. For modeling, Internet sites offer rich sources of poetry examples (e.g., the website of the Academy of American Poets at <http://www.poets.org>) and examples of student writing (e.g., at <http://www.thewritesource.com/studentmodels>).



**FIGURE 7** Concept Map for *To Kill a Mockingbird*

In addition, several kinds of programs and websites are available to help the slow-to-write student get started, including story starters, like Scholastic's whiteboard-ready site Story Starters, and Scholastic's Poetry Idea Engine (both listed in the Open-Source Options feature). Many language arts and writing teachers encourage student writing by assigning journaling. This assignment can be made more motivational by assigning blog posting or wiki interactions, rather than on-paper journals. See Technology Integration Example 2 for a variety of ways blogs can encourage student writing.

Free sites to set up blogs and wikis are listed in the Open-Source Options feature. With blogging and wiki exchanges, students have an audience for their writing and their posts become, as Bromley (2010) says, "dynamic sites for conversation" (p. 100) with their colleagues, rather than just products for a grade in school.

**Using word processing to produce written drafts.** As students draft their papers, they continue to plan, rethink, and reorganize their work, even while producing more text. Word processing programs aid drafting by allowing students to make changes as they write, thus making drafting a more fluid process. It is preferable if students learn to draft directly on the computer using word processing software, rather than handwrite their drafts, since it facilitates later revision and editing. When computer access is a concern, teachers

sometimes ask students to handwrite their drafts, then enter them into the computer when a computer becomes available. However, this is not the most efficient approach to drafting and should be avoided, if possible, since it provides a poor model for future work using word processing. Students need to learn to draft directly onto word processing pages.

**Modeling to support revising and editing written drafts.** Revising is the stage during which students make changes in content or structure that reflect decisions about how to improve overall quality. To revise well, students have to move from composing text to analyzing it, looking for what needs to be added, deleted, or rearranged. One of the best ways for teachers to assist in this process is to project a student's typed draft onto a screen or whiteboard and then model the thinking and decision making that goes into analyzing and revising the text. If projected in this way, students can make changes to the text as other students watch.

Editing, as opposed to revising, is the process of refining a paper so that it adheres to standard conventions for spelling, syntax, punctuation, and style. Editing is a far more superficial task than revising but no less important. All word processing programs have features that support the editing process, including spell-checkers and grammar checkers, as well as electronic search capabilities to verify consistency of word usage, tone, and tense. Once again, the teacher can model the editing process, and students can then edit each

**TECHNOLOGY INTEGRATION EXAMPLE 2****STRATEGIES TO ENCOURAGE WRITING****TITLE:** "My Pet is Special" Blog**CONTENT AREA/TOPIC:** Language arts, writing**GRADE LEVELS:** All grades**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts**21ST CENTURY SKILLS:** Core subjects: English; Communication and Collaboration: Communicate clearly, collaborate with others; Creativity and Innovation: Work creatively with others; ICT Literacy: Apply technology effectively**DESCRIPTION:** Blogs are a popular way to help students engage with text and provide opportunities for an authentic writing experience. One way to encourage writing in this way is to set up a classroom blog in which students exchange information about their current or desired pet. The teacher models how to use the blog by writing about his or her own pet and what is so special about it. Then students are encouraged to submit daily or weekly updates to their posting and respond to each other's posts.**Source:** Based on concepts from Lorrie Jackson's "This Bird Can Blog: Online Writing with a Twist" article on blogs at the Educational World website: <http://www.educationworld.com>

other's papers. The teachers may ask students to use color to highlight elements, such as the thesis sentence, supporting sentences, and transition sentences within a passage. This makes the structure more visible and aids editing and revising.

**Providing feedback with grammar, spell-check, and thesaurus features.** Most word processing programs have automatic grammar and spell-check features that flag problems in written text. For example, Microsoft's *Word* program underlines in red words it perceives as misspelled and underlines passages in green to highlight possible grammar problems. Word processing programs do not always offer correct "advice," but teachers can show students how to use these prompts to check for and correct mistakes in their writing. To improve written vocabulary use, students can also access the program's thesaurus, which offers a variety of alternative synonyms to given words.

**Providing feedback on student writing with editing tools.** Dunford and Fink (2011) offer advice on how to use three of Microsoft *Word's* built-in revision and automation tools to give students useful feedback on their word-processed drafts. These tools include: comments, autocorrect, and track changes. Comments are typed words placed in the margins of a document to remark on specific words or sentences. Teachers can insert comments on drafts to give written feedback on the draft. Word-processed comments produced with the Comment feature are preferable to handwritten comments because they are often easier to produce and read. **Autocorrect** is a built-in feature that automatically detects and corrects misspelled words and incorrect capitalization. Dunford and Fink explain how to insert

## Free open source **OPTIONS** for Free Software for English and Language Arts

**TYPES****FREE SOURCES****Free word processing software**AbiWord: <http://www.abisource.com>Google Docs WP: <http://www.google.com/google-d-s/documents>Writer: <http://why.openoffice.org/images/writer-big.png>Zoho Writer: <http://writer.zoho.com>**Story starters**Scholastic's Story Starter site: <http://teacher.scholastic.com/activities/storystarters/storystarter1.htm>**Blogs and wikis**Blogger (now hosted by Google): <http://www.blogger.com>Wikispaces: <http://www.wikispaces.com>

other automatic changes into the standard set that *Word* uses. **Track changes** is an editing command that can be turned on from one of the program's drop-down menus to show changes as they are made to an original document. Changes can either be accepted or rejected later. Each of these built-in features can save teachers editing time and make writing problems and mistakes more visible to students.

**Digital publishing of student work.** Students find it more motivating to write when they know their work will be shared with others. Now students can share their written works in forums such as websites, electronic books, multimedia slide shows, and news broadcasts. Email and website projects are also a way to connect student writers with distant audiences. Electronic penpal (sometimes called keypal) projects are popular and provide creative and authentic opportunities for communication. One handy reference on electronic penpals is the ePALS Global Community (<http://www.epals.com>), which connects millions of students and educators in 200 countries who want to work together. Finally, look for sites set up especially for publishing student work. These currently include KidPub, Bookworm, the WriteKids, and Your Student News.

## Support for Literature Learning

The other area of traditional literacy after reading and writing instruction is learning about great works of literature and learning to read literature with a discerning, critical, and appreciative eye. Three strategies for using technologies to support literature learning are described in this section: accessing free copies of published works, accessing information about authors, and support for literary analysis.

**Accessing online copies of published works.** Many authored works whose copyrights have expired are now available free from online sources. In addition, Google has undertaken a project to digitize a large number of copyrighted and un-copyrighted texts of all kinds. Allowing students to access these digital versions of texts promotes reading by making texts less expensive and more easily accessible. Just a few such sites are given in Table 1, though there are many more.

**Accessing background information on authors.** Since an author's life usually affects the choice of writing topics and may also affect his/her style, teachers often want students to learn about authors' backgrounds as a path for understanding the authors' written works. Again numerous websites are available. Teachers must choose these sites judiciously, since not all offer accurate or unbiased information. As with all websites, teachers can evaluate quality by noting the legitimacy of the sponsoring organization, how frequently the site is updated, if the site author can

be contacted, and spot-checking accuracy of information. Sites maintained by individuals should usually be avoided, as they may contain errors.

**Support for literary analysis.** When teachers want to engage students in reading and analyzing written works, they frequently ask students to focus on key words or phrases or look for patterns, such as meter. Two technology strategies support this kind of literary analysis:

- » **Projecting text for analysis**—Projecting text onto an interactive whiteboard is a great way to demonstrate analysis for the whole class. For example, see Figure 8, which shows students indicating meter in Edgar Allan Poe's *The Raven*.
- » **Using ereaders for analysis**—When text is on an ereader device, students can do searches and count instances of words or phrases that indicate mood or metaphor (e.g., search for the word "dark" in Poe's works). Depending on the device capabilities, students can also make notations directly on the text.

## TECH-PACK NEEDS AND CHALLENGES IN ENGLISH AND LANGUAGE ARTS

Although skills in the new digital literacies weave across and within all content area standards, they are especially evident in English and language arts because of the emphasis on reading, writing, and communication in this area. Students must still learn to read, but nowadays they must also learn how to obtain and interpret meaning from texts in many different formats (e.g., web pages and blogs) and from non-text

**FIGURE 8** Students Using Whiteboard for Literary Analysis



Projecting text on an interactive whiteboard makes literary analysis exercises more interactive and visual. Photo by W. Wiencke.

communications such as videos and images. They must still learn to write, but they also must learn to communicate with still and motion images and sounds. For this reason, teachers' Tech-PACK in this area means knowing how and when to use technologies that help guide the development of reading and writing skills in all current digital formats.

Writing is a focus of most English and language arts curricula. A teacher who exhibits Tech-PACK planning considers how technology tools enhance and help accomplish the goals and objectives of writing. For example, when teaching a lesson about writing stories, instead of having students just write stories using only text (printed or typed), a teacher who thinks from the Tech-PACK perspective considers how having students use a digital medium, such as a video, audio, or presentation software, to tell their stories (as illustrated in the Technology Integration in Action example at the beginning of this chapter) helps address both traditional and digital literacies. Not only does the use of digital technologies extend the story in ways not possible in print, a digital publishing medium also expands the potential audience for sharing the story (in that case, with blogs and websites).

Exhibiting an appropriate level of Tech-PACK presents several unique challenges to English and language arts teachers. These challenges are discussed here from the perspective of each of the separate Tech-PACK components. Finally, strategies for improving one's Tech-PACK are given.

## English and language Arts Content Knowledge

Some English and language arts content standards have remained relatively constant over the years. Students still need to read and comprehend text at their grade level and write for expository and persuasive purposes. However, digital literacies have added a new dimension and an array of required skills. Teachers must now think in terms of visual and graphic literacy, as well as reading and writing literacy. In the future, students will not only be expected to exhibit verbal and written fluency in traditional text formats, they will be expected to become proficient in technologies such as ereaders that allow them to read and search content in documents. Also, they will be expected to interpret and produce communication in video and images, as well as in text form. The task of teaching all these new skills will be primarily the responsibility of English and language arts teachers. Thus, there is more content for new teachers in this area to learn than ever before.

## English and language Arts Pedagogical Knowledge

Government reports say that approximately one child in four grows up not knowing how to read, and many American



To be able to teach the new literacies, teachers must become proficient in the new tools that both help define literacy in the 21st century and make possible the strategies to teach it.  
Photo by W. Wiencke.

adults remain functionally illiterate (U.S. Department of Education, 2007). Teaching writing skills continues to be a challenge, according to the last National Assessment of Educational Progress (Salahu-Din, Persky, & Miller, 2008). One of the main reasons contributing to this challenge is the increasing numbers of students who enter school speaking English as a second or third language. Teachers must acquire new pedagogical skills and create new strategies to meet the special needs of this increasingly diverse population.

## English and language Arts Technological Knowledge

To be able to teach the new literacies, teachers must become proficient in the new tools that both help define literacy in the 21st century and make possible the strategies to teach it. These include ereaders, blogs and wikis, web pages, and presentation software, as well as digital cameras, video editors, image manipulation software, and audio editors. Finally, they must become informed consumers of online sites that can support instruction in all of the areas of English and language arts.

## Strategies for Improving Tech-PACK in English and Language Arts

Strategies to improving Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

- » **Do I have the English/language arts content knowledge I need to assist my students in meeting the**

**standards within my classroom?** The biggest challenge to English/language arts teachers are the “new literacies” which require learning new content in digital and information literacies. If an English/language arts teacher needs updates to content knowledge of any kind, the most likely options are workshops or other kinds of professional development offered by the International Reading Association, the National Council of Teachers of English, or the state affiliates of these organizations. Attendance at conferences held by these professional organizations can be helpful.

- » **Do I have the technological knowledge needed to teach the English/language arts content within my classroom?** Though most English/language arts teachers are familiar with general word processing features, they may not be familiar with some aspects of this software such as track changes and autocorrect. In addition, skills that are fundamental to digital and information literacy will require many teachers to learn a number of technologies that may be new to them. These include various kinds of software to support word development skills, ereaders, portable assistive devices, blogs, wikis, and sites that offer online access to authored works and locations to publish student work. The IRA and NCTE organizations may have professional development, but

one of the best resources for workshops in these topics is the International Society for Technology in Education (ISTE), which sponsors the annual ISTE Conference, as well as a number of texts on these topics.

- » **Do I have the pedagogical knowledge needed to teach the English/language arts content within my classroom?** The same sources that offer content and technology knowledge may also be tapped to show teachers how to use new technologies in the ways described in this chapter. For example, teachers may want to see how to integrate blogs and wikis most effectively or carry out lessons using digital storytelling or using whiteboards for literary analysis lessons. The IRA’s ReadWriteThink site offers materials and lesson plan ideas.

At the end of this chapter, you will deconstruct a teacher’s Tech-PACK based on what you know of their knowledge and what must be learned to teach English/language arts effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone in your own content area.



## SUMMARY

(left to right) © Shutterstock, Fotolia, iStockphoto, Shutterstock

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

**1. Issues and Problems in English and Language Arts**—Each of these current issues has implications for how teachers can and should integrate technologies. These include: teachers’ responsibilities for the “new literacies”; the need for new instructional strategies; challenges of working with diverse learners; challenges of motivating students to read and write; teachers’ growth as literacy professionals and leaders; and whether or not to require instruction in QWERTY keyboarding.

**2. Technology Integration Strategies for English and Language Arts**—Integration strategies offer support for word

fluency and vocabulary development, comprehension and literacy development, writing instruction, and literature learning.

**3. Tech-PACK Needs and Challenges in English and Language Arts**—To integrate technologies effectively, teachers must have a combination of English and language arts content knowledge, pedagogical knowledge, and technological knowledge.



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** In her article, "A Is for Avatar," Karen Wohlwend (2010) says that "in a time of massive global technological innovation in which new literacies are popping up almost daily, U.S. schools are clamping down rather than ramping up" (p. 144). What does she mean by "clamping down?" Can you find newspaper, magazine, and journal articles that demonstrate this "clamping down" by specific school systems? (Hint: What are most schools' policies regarding cell phones?) Do you feel there are legitimate reasons for why this is happening? Defend your position for or against the need to "clamp down," as opposed to "ramp up."

**2.** Many educators believe that budgeting for computer equipment, software, and infrastructure can be defended because digital and information literacy are as important—if not more important than—traditional reading-and-writing literacy. Do you feel this is true? What information and/or conditions in today's schools do you feel should inform policy makers on the relative priority of these "old and new" kinds of literacy?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- a. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- b. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- c. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Mr. Phillips is an English teacher with 25 years of experience in teaching writing and literature. He feels he has become skilled at motivating his students and engaging them with various forms of literature. Some of his students from 15 or 20 years ago come back to visit him and tell him that he was their best teacher. However, no students from the past 10 years have come back to visit him, and about a quarter of his students have become very difficult to motivate; they resist doing his reading and writing assignments. He has become convinced that he has a responsibility to teach digital literacy and information literacy skills as an integral part of his content. However, he has not attended a workshop or professional conference in some years, and he feels at a loss to know where to begin. He has his students use word processing to finish up their written assignments, but they have to write their first drafts by hand. He has his students use the Internet only for doing background research on their written reports.*

- a. Deconstruct Mr. Phillips’s Tech-PACK in the following way. Fill in the following matrix to show what he knows and what he will have to learn in terms of content, technologies, and pedagogies in order to be in his Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that he must address to implement this new strategy effectively in his classroom.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.

- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?

- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



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.



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# TEACHING AND LEARNING WITH TECHNOLOGY IN FOREIGN AND SECOND LANGUAGE INSTRUCTION

# TEACHING AND LEARNING WITH TECHNOLOGY IN FOREIGN AND SECOND LANGUAGE INSTRUCTION

Sometimes the technology resources that world language teachers have at their disposal seem more like a magic carpet or a magic wand, capable of transforming teaching and curriculum in ways that would have been unimaginable a decade ago.

But technology is just a tool: the skilled teacher, like the skilled craftsman, matches the tool to the task in order to accomplish an important purpose.

From the School Computing: Technology in Foreign Language Learning wiki [http://schoolcomputing.wikia.com/wiki/Technology\\_in\\_Foreign\\_Language](http://schoolcomputing.wikia.com/wiki/Technology_in_Foreign_Language)



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## o u t c o m e s

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

1. Recognize the implications for technology integration of each current issue faced by second language and foreign language teachers.
2. Create key strategies for integrating technology into second language and foreign language curricula.
3. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to second language and foreign language teachers.

## key terms

Blended Intercultural Telecollaborations computer-assisted language learning (CALL)

English as a Second Language (ESL) English Language Learning or Learners (ELLs)

foreign language (FL) machine translation



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## TECHNOLOGY INTEGRATION IN ACTION: WRITING IN BLOGS EN FRANÇAIS

GRADE LEVELS: 9–12 • CONTENT AREA/TOPIC: French, art • LENGTH OF TIME: One semester

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

The French teachers at Sabine High School agreed that their students needed more practice writing in French. They had tried various kinds of writing assignments, but students always seemed to do the minimum required, and their fluency in writing the language remained low. The teachers agreed that students would be more motivated if assignments had greater purpose and a real audience. While visiting another school, one of the teachers saw a project for Spanish language students that seemed to fulfill all of these requirements. The teachers at that school held a Spanish art identification contest using an asynchronous online discussion board. They posted images of Spanish art, and students had to identify the pieces and discuss and describe the art en Español on the discussion board. Students who were the first to do these tasks earned points, and students who accumulated the most points won recognition and prizes. The Spanish teachers said that the strategy worked well for students learning English as well. Also, the



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project exposed students to some important artwork from the Spanish-speaking countries the students were learning about. Since students were already used to writing in blogs with their English classes, the French teachers decided to implement the project using these blogs.

### Step 2: Assess Tech-PACK.

**Content and Pedagogical Domains.** Both the teachers were veteran language teachers. Language teachers who were new to the district or to teaching often consulted them to learn about effective materials and strategies they could emulate. One of the teachers grew up speaking French as a first language, but had been in an English-speaking environment for many years. However, neither teacher had been in a French-speaking country for some time. They both knew that their students might hear idioms and phrases that they, the teachers, were not familiar with and would have to look up.

**Technology Domain.** Both teachers considered themselves computer savvy and used the Internet and email for various tasks. For example, they had their students do online French vocabulary drills. However, neither had experience in blogs or international projects. They knew there would be a steep learning curve at the beginning, but they were excited at the prospect.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

The French teachers wanted to make sure the expectations for the project were clear to students and teachers alike, so they agreed on the following objectives and assessment methods to measure students' performance:

- » **Outcome:** Participate in blogs on artworks. **Objective:** All students access each of the blogs and post all of the required descriptions. **Assessment:** A checklist of items students were required to post about each artwork, with points for each posting and extra points for being first or second to identify and describe the artwork.
- » **Outcome:** Improved writing in French. **Objective:** All students will demonstrate improved writing in French by achieving a 90% rubric score. **Assessment:** A rubric to assess the quality and quantity of students' descriptive writing in French.
- » **Outcome:** Demonstrate knowledge of artworks. **Objective:** Each student must score at least 80% on a short-answer test on art from French-speaking countries. **Assessment:** A test consisting of questions on the art discussed in the blogs.

### Step 4: Design integration strategies.

The teachers knew that it would take some time to review students' French language skills, prepare content and procedures for the blogs, and get students used to working with them. They designed the following sequence of activities to prepare for and carry out the project:

- » **August–December:** Prepare artwork graphics to place on the school website and do administrative tasks to use blogs. Develop students' descriptive vocabulary related to art (e.g., nature morte, paysage, croquis, aquarelle, gravure, toile) and language to express their opinions about art (e.g., *J'aime vraiment cette peinture à l'huile*). Develop students'

## ISSUES AND PROBLEMS IN FOREIGN AND SECOND LANGUAGE LEARNING

There are two forms of language learning: second language learning and foreign language learning. When language learners are in a classroom with an English-speaking environment, English is the second or additional language for them and students are referred to as **English language learners (ELLs)**. (This used to be called **English as a second**

**language** or **ESL**. However, the more commonly-used term is now **ELL**.) However, when the language being studied is spoken mainly in other countries, it is referred to as **foreign language (FL)** learning. While the underlying processes of learning **ELL** and a **FL** are similar, there are also many differences relevant to teaching and technology integration strategies. Key differences are the availability of the language input in the environment and opportunities for using the language in meaningful situations.

Unlike learning a foreign language, **ELL** learners have many more opportunities for learning English because it is

knowledge about the French-speaking countries and cultures from which the art originates.

- » **January:** Introduce the blogging and the art identification tasks. Assign the first blog as a practice to iron out any logistical problems. Review the items students are required to post about each artwork, and review assessment strategies. Remind students that they can see each other's postings and can complete the assignment requirements in the context of a reply to a classmate.
- » **February–April:** Introduce one blog for credit each month. Assess each, and review the answers to the blog at the end of the month.
- » **May:** Review points won, recognize students, and award prizes.

### Step 5: Prepare instructional environment.

The teachers knew that setting up the activity would require some concerted effort the first time they did it, so they divided the following tasks among themselves to lessen the load on each of them:

- » **Setting up blogs:** Teachers obtained the required information about how to create blogs and set up one blog for each month. Each student needed to have a unique sign-on, so they made a list of students, created usernames and passwords for them, and entered them into the system.
- » **Preparing content for assignments:** Teachers selected a set of paintings and sculptures for each blog, making sure they represented various French-speaking countries and cultures they had studied. For each blog, they wrote a set of questions to be answered about the pieces of art.
- » **Preparing assessments and handouts:** Teachers created the checklists and rubrics they would use to assess student progress. They also prepared a handout describing the project and giving the URLs for accessing the system.
- » **Ensuring student access:** Teachers had already confirmed that most students had Internet access at home. However, to make sure everyone had adequate time and access whenever they wanted it (so they all had equal chance to be first with the correct answers), the teachers designated times

when students could get online in their classrooms and in the language lab.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

Teachers observed that students posted increasingly faster for each blog and that most wrote more sentences each time. By having a clear purpose for writing that allowed for student choice, the project helped develop students' writing skills. Furthermore, the teachers noticed that there was more interaction between students with each successive blog, which speaks to the benefits of having an interested audience when writing in a foreign language, even if this audience includes students' classmates and other classes in the school. The test on students' knowledge of art and culture showed that students had learned a lot about art from the countries they were studying. When the teachers interviewed the students, it was apparent that all were enthusiastic about the project, with a few exceptions. Students who had no Internet access at home or had to share access with family members felt it was unfair that others had more opportunities to look up and post answers.

### Step 7: Make revisions.

The teachers decided to designate more time in each blog for lab work so that all students would have the access they needed. Students also suggested that the competition be by class instead of across classes, giving more students opportunities for winning awards. The teachers decided that the project had worked so well that they would expand it to include musical works by French-speaking musicians next time.

**Source:** Based on a concept from: DeLuca, A., and Hoffman, B. (2003). *Vamos a darle algo a discutir* (Let's give 'em something to talk about). *Learning and Leading with Technology*, 30(5), 36–41.

a majority language that is being spoken all around them. They also have urgency to learn the language quickly because they need English for everyday tasks, employment, and educational purposes. Conversely, FL learners typically have fewer opportunities to practice the foreign language, and teachers often go to great lengths to find people and places with whom and where their students can use the target language. FL learning is different than ELL learning in that it is often seen as enrichment rather than a matter of crucial importance for academic success. This section introduces key problems of practice for learning in each setting.

## ELL Issue #1: Demands on Content Area Teachers

As the U.S. population becomes increasingly diverse and children from many different countries and cultures enter American schools in large numbers, teachers face a continuing challenge to teach content to students with limited English proficiency to meet academic standards mandated by the state and by their local district. In addition, many states have discontinued funding for special classes or bilingual approaches and have begun placing these students

into regular classroom settings in which instruction is entirely in English. Many ELL students are not literate in their first language, which compounds the problem. These students must be taught to read, so teachers must teach them to speak and read English at the same time. Teachers often have students in their classrooms with many different home languages. Technology tools give teachers some of the support they need to meet widely-varying needs of ELL while still proceeding with regular classroom instruction for other students. For example, activities such as those on *Brainpop* are available to let students practice their vocabulary and English skills individually, both in the classroom and on their own. Also, many online translation sites are available that can scaffold students' current knowledge by providing on-the-spot translations of directions and classroom tasks. Mobile devices have made these aids more portable and easier to access from any location.

O'Dowd (2011) notes that providing more authentic experience through intercultural exchanges "remains a relatively peripheral 'add-on' activity in most foreign language classrooms" (p. 1). The same may be said of ELL classes. The pressures of preparing students to meet curriculum standards, in addition to the logistical issues in implementing what O'Dowd calls "telecollaborations," make it difficult for teachers to find classroom time for these valuable experiences.

## **ELL Issue #2: Academic and Language Prerequisites for ELLs**

Typical grade-level content materials are above the reading proficiency levels of ELL students. Technology offers some helpful solutions to a common problem faced by K–12 ELL teachers: developing their students' academic language and background knowledge sufficiently for them to participate in mainstream classes. For example, a high school English language learner who has a low level of proficiency but much knowledge of current events can make use of multimedia content on the websites of national and local newspapers, magazines from across the spectrum of pop culture such as *Sports Illustrated* or *People*, or television stations like ESPN and CNN. On these websites, students can look at photos with short captions, listen to podcasts, and watch videos on topics of their choice. In addition to lessening the reading load, these highly-visual options give learners with lower levels of proficiency access to authentic information on high-interest, current topics. Initially, students may need guidance in navigating these kinds of websites. They need to learn what the icons mean, how to use the headings, and how to recognize the key vocabulary words—that is, acquire the basic media literacy needed to benefit from the tools.

It is often helpful for English language learners to read text designed for native English speakers who are younger than they are, if the materials are not too childish and the task assigned is age-appropriate (e.g., compare and contrast three versions of the Cinderella story through literary and cultural lenses). One useful resource for finding books with relevant academic and cultural content for English language learners is the International Children's Digital Library, a searchable, multilingual children's library. The listed books are appropriate for children from 3 to 13 years of age, but they may also work well for older English language learners, particularly the nonfiction books. There are also many websites that have simplified language and interesting pictures and visuals, such as Desert USA and National Geographic.

## **ELL Issue #3: The Need to Differentiate Instruction**

In many ELL settings, teachers need to deliver instruction across a wide range of proficiency levels. Unlike FL classes, ELL teachers cannot assume their classes have been divided according to proficiency level. Older English language learners come with a range of print literacy skills in English and their native language as well as a wide range of prior formal schooling experiences. It is common at the elementary level to collaborate with a grade-level teacher to deliver ELL services; at the upper levels, students of different needs are sometimes served in stand-alone classes, sheltered content classes, and ELL classes. Technology can help the teacher differentiate instruction through software that assists in tracking individual students and can offer ways for students to work independently on developing their reading, writing, speaking, and listening skills. Oral and written language practice programs can offer individuals simulated authentic practice while the teacher is working with other students. With the new multimedia programs that include actual spoken models, ELL students can use the computer to help them practice their oral English language production. In addition, grammar check programs allow students to receive instant feedback on their use of vocabulary and verb tenses as they practice their written English.

## **ELL Issue #4: Challenges of Integrating the Students' Native Languages**

Efforts to prepare students for mainstream classes in English often require building background knowledge in the content area so that when they are confronted with grade-level content instruction, students have a knowledge base upon which to acquire new knowledge. One of the easiest ways

to do this is to use students' native languages. Based on Cummins' Linguistic Interdependence Hypothesis (Proctor, August, Snow, & Barr, 2010), use of students' native languages also serves to build students' skills in their native languages, which in turn facilitates skills in English. An additional benefit of using the students' native languages to help them gain access to grade-level content is that they come to see that their native languages are valued as a resource at school. This practice creates a more welcoming learning environment for immigrant children and youth.

Technology can assist teachers in using the students' native languages even when the student speaks a less common native language. Many new programs allow teachers to create vocabulary lists specific to their lessons. These can help prepare students who have few other scaffolds be more successful in participating in grade-level and content classrooms. Using a computer to translate from one language to another, or **machine translation**, can be helpful to teachers and students. For this translation, they can now use online websites, as well as handheld devices. However, they must be aware of the controversy surrounding online translation sites

(see the Hot Topic for Debate feature). This seems particularly true for online searches. From their text-analysis study using translators before online searches, Dolamic and Savoy (2010) concluded that "writing a topic in another language and then asking Google or Yahoo! to automatically translate it before launching a search will significantly degrade retrieval effectiveness" (p. 2272).

Teachers can look up key content words in the students' native languages or translate some simple instructions on a project. For students, the tools function like bilingual dictionaries and help them unlock the meaning of a text both at the word level and the phrase level. Several of these tools are shown in Figure 1. Though many of these tools offer translations only in common foreign languages (e.g., French, Spanish, Chinese, Korean), some are beginning to include languages less commonly seen in U.S. classrooms (e.g., Farsi, Hmong, Somali).

Another way to bring students' native languages into the ELL class is through electronic newspapers from around the world. It is possible to access newspapers in most languages found among English language learners on the Internet, as

## Hot Topic Debate

### ARE ONLINE (MACHINE) TRANSLATORS APPROPRIATE TO USE WHEN LEARNING A FOREIGN LANGUAGE?

*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 2009 article in *Die Unterrichtspraxis*, "Machine Translation in the German Classroom: Detection, Reaction, Prevention," Sören Steding says that use of online language translation sites should be strictly forbidden in German language learning. He notes that while some authors feel that MT has a

place in the classroom, "many language instructors probably will encounter it as an uninvited guest" (p. 178). This is because students usually use it without questioning the accuracy of the translation; to them, if the Internet site supplies it, it must be okay. Also, giving a machine-translated text can be considered plagiarism ". . . because it is passing off the ideas or words of another (here: the software) as one's own" (p. 178). He says, "The first step in Machine Translation-prevention in the German classroom is to make it absolutely clear to students that the use of machine translation is not allowed. The penalty for using machine translation should be spelled out clearly" (p. 186). Do online translation sites have a place in language learning classrooms? What evidence can you cite that helps define an appropriate and helpful role that supports both instructors and students?



## FIGURE 1 Sample Machine Translation Sites

<b>Babylon Online Translation:</b>
<a href="http://translation.babylon.com">http://translation.babylon.com</a>
<b>Free Translator:</b>
<a href="http://www.freetranslation.com">http://www.freetranslation.com</a>
<b>Google Translate:</b>
<a href="http://translate.google.com">http://translate.google.com</a>
<b>Yahoo's Babel Fish:</b>
<a href="http://babelfish.yahoo.com">http://babelfish.yahoo.com</a>
<b>World Lingo:</b>
<a href="http://www.worldlingo.com">http://www.worldlingo.com</a>

long as the computer is set up to read the fonts used in languages that do not use the Roman alphabet. Students can read about many topics relevant to their classes in newspapers in their native language.

### FL Issue #1: The Need for Authentic Materials and Perspectives

Often FL teachers are non-native speakers of the languages they teach and may have infrequent opportunities to spend extended periods of time in countries where their FL is spoken. Therefore, there is a need to find ways to expose students to both a range of native speakers of the FL, including varieties of the language not spoken by the teacher, and to up-to-date examples of how the language is currently used. Technologies are available to make these connections possible. Using websites and projects to connect students with speakers from around the world, students can also experience the cultural, political, and individual perspectives of those who speak the language of study. An increase in authentic perspectives and materials designed for native speakers of the language taps into high-quality teaching of culture using the standards set forth by the American Council on the Teaching of Foreign Languages (Standards for Foreign Language Learning, 1999, see <http://www.actfl.org/i4a/pages/index.cfm?pageid=3392>). The standards integrate perspectives, products, and practices to teach culture. When all three components are integrated into a FL curriculum, they work together to deepen students' cultural competency. Technology can bring insider voices and authentic materials into the FL classroom to teach culture through perspectives, products, and practices.

### FL Issue #2: The Need for Creating Audience and Purpose

Another common problem related to practice opportunities for FL teachers and their students is creating a broader repertoire of individuals to talk with and audiences that wish to read their writing. Technology-based projects can assist with the need to provide both means and a reason to contact native language speakers. With online video and audio conferencing tools (e.g., Skype), students are now able to talk with peers in other countries and interact with presenters who visit their class via these inexpensive online tools (Bahrani, 2011). Blogging and wiki functions also offer a platform for writing to classmates and with students in other classes about collaborative projects or reviews of movies or music (Castleberry & Evers, 2010). Online publishing offers students an audience beyond their teachers and can give students an incentive to revise their work. There is a wide array of opportunities for sharing student writing with new audiences.

## TECHNOLOGY INTEGRATION STRATEGIES FOR ELL AND FL INSTRUCTION

**Computer-assisted language learning (CALL)**, an accepted term for using computers in language testing, teaching, and learning, has made great strides in offering students new ways to enhance their speaking and listening skills. There are now a variety of technology-based tools available to support both ELL and FL learners in and out of class. These strategies include support for authentic oral language practice, virtual collaborations, virtual field trip immersion experiences, language subskills practice, presentations, text production, and productivity and lesson design support for teachers. See a summary of these strategies and the resources to support them in Table 1.

Castleberry and Evers (2010) say that “media such as digital text, digital images, digital audio, digital video, digital multimedia, hypertext, and hypermedia have malleability that can provide opportunities for learning that may not be possible with print text and traditional teaching methods...Technology opens the doors of modern language classrooms to students with diverse needs because it allows access to the curriculum as well as information about language and culture” (p. 202). They offer 20 different ways to use technologies to support language learning, all of which are discussed in various parts of this section. See the Adapting for Special Needs feature with more tips for addressing these. See also the Top Ten feature for

recommended strategies for developing the full range of language skills.

## Support for Authentic Oral Language Practice and Assessment

Several technologies are available to enhance and support a more authentic approach to language learning and assessment. These include the following:

» **Videoconferencing**—New and inexpensive technologies help teachers connect FL students with native

speakers in other countries. Quillen (2011) says that many FL teachers claim that, in addition to making interactions with native speakers more feasible logistically, “aspects of video communication actually make teaching and learning more effective than the comparable in-person experiences.”

» **Multimedia software and interactive (electronic) storybooks**—These technologies, designed to support language acquisition and vocabulary development, have several strengths. First, they allow teachers to individualize instruction for students’ differing language levels. Second, they give students an opportunity to

**TABLE 1 Summary of Technology Integration Strategies for ELL and FL Learning**

Technology Integration Strategies	Benefits	Sample Resources and Activities
Support for authentic oral language practice and assessment	<ul style="list-style-type: none"> <li>Helps provide individual help for students’ different language levels</li> <li>Helps students internalize word meanings and gives additional practice in using new words.</li> <li>Gives practice in following oral English direction, and in reading and responding in written English</li> <li>Builds listening competence</li> </ul>	<ul style="list-style-type: none"> <li>Scholastic interactive storybooks: <a href="http://teacher.scholastic.com/clifford1">http://teacher.scholastic.com/clifford1</a></li> <li>Leapfrog products: <a href="http://www.leapfrog.com/school">http://www.leapfrog.com/school</a></li> <li>Living Books: <a href="http://www.classsource.com/livingbooks">http://www.classsource.com/livingbooks</a></li> <li>Natural Reader: <a href="http://www.naturalreaders.com/index.htm">http://www.naturalreaders.com/index.htm</a></li> <li>ReadPlease: <a href="http://www.readplease.com">http://www.readplease.com</a></li> <li>Auralog’s Tell Me More Series: <a href="http://www.tellmemorestore.com">http://www.tellmemorestore.com</a></li> <li>Rosetta Stone: <a href="http://www.rosettastone.com">http://www.rosettastone.com</a></li> <li>Transparent Language: <a href="http://www.transparent.com">http://www.transparent.com</a></li> <li>Penpower WorldpenScan Pro: <a href="http://www.penpowerinc.com">http://www.penpowerinc.com</a></li> <li>Lingo Talking Translator: <a href="http://www.lingotravel.com">http://www.lingotravel.com</a></li> <li>Radio broadcasts from NPR: <a href="http://www.npr.org">http://www.npr.org</a></li> <li>Radio broadcasts from Multilingual Books Online: <a href="http://www.multilingualbooks.com/online-radio.html">http://www.multilingualbooks.com/online-radio.html</a></li> </ul>
Virtual collaborations	<ul style="list-style-type: none"> <li>Helps motivate students to use new language skills</li> <li>Helps students learn more about cultural contexts of languages they are learning</li> </ul>	<ul style="list-style-type: none"> <li>Global SchoolNet: <a href="http://www.globalschoolnet.org">http://www.globalschoolnet.org</a></li> <li>ePals Global Community: <a href="http://www.epals.com">http://www.epals.com</a></li> <li>My Language Exchange: <a href="http://www.mylanguageexchange.com">http://www.mylanguageexchange.com</a></li> <li>Global Friends Group: <a href="http://esl-group.com">http://esl-group.com</a></li> <li>The Mixer: <a href="http://www.language-exchanges.org">http://www.language-exchanges.org</a></li> </ul>
Virtual field trips for modified language immersion	<ul style="list-style-type: none"> <li>Offers expanded opportunities for language acquisition</li> <li>Allows students to “visit” locations and have experiences not available to them in person</li> </ul>	<ul style="list-style-type: none"> <li>InterLingo Spanish: <a href="http://www.interlingospanish.com">http://www.interlingospanish.com</a></li> <li>Tramline Virtual Field Trips: <a href="http://www.field-guides.com/trips.htm">http://www.field-guides.com/trips.htm</a></li> </ul>
Support for practice in language subskills	<ul style="list-style-type: none"> <li>Provides intense, targeted practice in specific language skills and vocabulary sets</li> <li>Provides immediate feedback to correct common errors students make</li> <li>Incorporates current vocabulary of specific classroom lessons</li> </ul>	<ul style="list-style-type: none"> <li>Tower of English: <a href="http://www.towerofenglish.com/games.html">http://www.towerofenglish.com/games.html</a></li> <li>English Banana: <a href="http://www.towerofenglish.com/games.html">http://www.towerofenglish.com/games.html</a></li> <li>Pinyin Practice: <a href="http://pinyinpractice.com/wangzhi">http://pinyinpractice.com/wangzhi</a></li> <li>Quia: <a href="http://www.quia.com/web">http://www.quia.com/web</a></li> <li>ELL Software for Schools: <a href="http://www.esl.net/software_schools.html">http://www.esl.net/software_schools.html</a></li> <li>Japanese tools (including a Japanese word processing program): <a href="http://www.learn-japanese.info">http://www.learn-japanese.info</a></li> </ul>

*Continued*

**TABLE 1** Summary of Technology Integration Strategies for ELL and FL Learning (continued)

Technology Integration Strategies	Benefits	Sample Resources and Activities
Presentation aids	<ul style="list-style-type: none"> <li>Helps reduce student stress and focus their presentations</li> <li>Teaches valuable skills in making effective presentations</li> <li>Makes classroom presentations more understandable and more enjoyable for both presenters and listeners</li> </ul>	<ul style="list-style-type: none"> <li><i>PowerPoint</i>: <a href="http://office.microsoft.com/en-us/powerpoint">http://office.microsoft.com/en-us/powerpoint</a></li> <li>2Learn.ca: <a href="http://www.2learn.ca">http://www.2learn.ca</a></li> </ul>
Support for text production	<ul style="list-style-type: none"> <li>Supports authentic use of language in creating documents (e.g., journals, reports)</li> <li>Helps correct students' written text through grammar and spelling checks</li> </ul>	<ul style="list-style-type: none"> <li><i>NJStar</i> Chinese word processor: <a href="http://www.njstar.com">http://www.njstar.com</a></li> <li><i>Volga-Writer</i> Russian word processor: <a href="http://www.volgawriter.com">http://www.volgawriter.com</a></li> <li>Word processing in many languages: <a href="http://www.multilingualbooks.com">http://www.multilingualbooks.com</a></li> </ul>
Productivity and lesson design support for teachers	<ul style="list-style-type: none"> <li>Saves teacher time in locating and preparing lesson ideas and materials</li> <li>Gives teachers access to a wealth of classroom-tested lesson ideas and strategies</li> <li>Provides models of effective technology integration</li> </ul>	<ul style="list-style-type: none"> <li>Content-Based Language Teaching through Technology (CoBaLTT): <a href="http://www.carla.umn.edu/cobalitt">http://www.carla.umn.edu/cobalitt</a></li> <li>Language lesson plans: <a href="http://www.celta.net/lessons">http://www.celta.net/lessons</a></li> <li>Intercultural Development Research Association: <a href="http://www.idra.org">http://www.idra.org</a></li> <li>Global Friends Group: <a href="http://esl-group.com">http://esl-group.com</a></li> <li>2Learn.ca: <a href="http://www.2learn.ca">http://www.2learn.ca</a></li> </ul>



## ADAPTING FOR SPECIAL NEEDS

### English as a Second Language Learning

Students whose first language is not English sometimes do not respond to teacher questions or participate more slowly than other students due to the multilingual processing they must use. Teachers can support learning for these students by allowing adequate time for cognitive processing and by encouraging students to make connections between their first language and English. Here are some useful classroom resources for these students:

» *Book Box* (<http://www.bookbox.com>)—View and listen to stories in one language along with second language captions.

- » *Simple Wikipedia* (<http://simple.wikipedia.com>)—Articles are written explicitly in simple English to reduce the complexity and eliminate jargon. This feature is also found in the main Wikipedia and is offered as a language translation option on the left column of the page.
- » *VocabGrabber* (<http://www.visualthesaurus.com/vocabgrabber>)—Paste in a section of text to have the vocabulary analyzed. Provides definitions, visualizations of synonyms, word frequency, and other resources.

Contributed by Dave Edyburn

interact in English authentically in a less stressful environment as compared to a face-to-face environment. Interactive books are a good example of using technology in this manner. These books appear on the screen, and the student can set the program to read the book aloud as he or she follows along, giving the reader the

chance to see the word and the illustrations and to hear the words pronounced. The reader can opt to read the story unaided, touching a word with a stylus when a prompt is needed. Many of these programs have additional learning games attached, using the vocabulary and illustrations from the storybook.



**TOP TEN**  
**Strategies for Integrating Technology in ELL/FL Instruction**

Take advantage of these ten powerful strategies for using technology to enhance the teaching of both English and foreign languages.

SOURCE	TRACK	SELECTION
Blended Intercultural Telecollaborations	<b>1</b>	Using email, blogs, wikis, online chats, and other communication technologies for international partnerships gives FL students valuable language-learning opportunities and intercultural insights with native speakers of languages.
Word processing	<b>2</b>	FL students use language-specific word processing programs that allow them to use special characters and check spelling and grammar as they practice writing in the target language.
Podcasts for listening instruction, practice, and assessment	<b>3</b>	Teacher-created audio and/or video files provide instruction students can use whenever they like; student-created podcasts for assessment and portfolios help students target needs and show growth.
Interactive storybooks support language acquisition	<b>4</b>	Students can strengthen their language skills by hearing the language read to them.
Virtual field trips provide simulated experiences	<b>5</b>	ELL and FL students see people and places they could not visit otherwise.
Handheld devices provide language skills support and practice	<b>6</b>	Students use these resources to get individual, private feedback to support their reading or practice their language skills.
Language labs support language acquisition	<b>7</b>	Students get multimedia instruction with monitoring, feedback, and authentic verbal interaction.
Presentation aids help scaffold students' language use	<b>8</b>	The visual formats of presentation software and videos help students demonstrate their range of language skills in nontraditional, collaborative, and engaging ways.
Websites offer exercises for students to practice subskills	<b>9</b>	Online exercises are easy to access and provide intense practice in specific language skills and vocabulary sets.
Downloaded Internet images	<b>10</b>	The Internet serves as a valuable resource for photographs and other images to add to teacher and student presentations.



Scholastic has a number of titles available in interactive (electronic) storybook format, including the Clifford series. Many of these interactive book programs emphasize vocabulary games to help students internalize

word meanings and to give additional practice in using the new words encountered in the storybooks.

Software series for learning various languages continue to be popular, particularly with older language

learners. Companies that offer these series include Rosetta Stone, Transparent Language, and Auralog. Links to these and other resources are listed in Table 1.

- » **Learning games on handheld devices**—LeapFrog also has learning games appropriate for language learners of various ages. Its series of handheld devices is designed to give elementary, middle, and high school students practice in math, science, social studies, and languages using content from the most common textbooks across the country. Newer devices also have multimedia and ereader capabilities (see Figure 2.)
- » **Language labs**—Vanderplank (2009), quoting Roby, says, “Within the field of education, the language laboratory must be seen as a singular phenomenon. By virtue of its unique equipment and specific pedagogy it stands alone. There is nothing quite like it in any other discipline” (p. 4). Though these labs have long been a mainstay in ELL and FL instruction, they have changed from strictly audio to more multimedia experiences for students. In the 1960s and 1970s, they consisted of audiotapes that students listened to and imitated. Since then, we have learned much about the importance of communication, authentic practice, monitoring, and feedback. Language labs look very different these days. Students now have headphones so they can hear themselves and self-monitor their oral production. The new language labs provide students with a recorder, video monitor, and/or a computer in each individual station, and activities are much more interactive. Activities such as recorded dialog journals, in which students speak about an assigned topic or a topic of their choice, give the teacher an opportunity for monitoring, feedback, and authentic verbal interaction. Listening instruction can be built into the lab setting by having

students listen to oral instructions while building a project such as a paper airplane, Lego construction, or origami figure.

Additional resources for building listening competence can be found at Randall’s Cyber Listening Lab (<http://www.esl-lab.com>). This site provides short (1- to 3-minute) and long (5- to 10-minute) listening exercises, as well as an array of other useful resources such as “culture videos.”

- » **Radio broadcasts**—For more advanced students, National Public Radio offers live radio broadcasts on the Internet that provide both news and drama from which teachers can create motivational activities to give the learner practice in oral and written language. Also, Multilingual Books Online provides links to radio stations in multiple languages around the world.
- » **Podcasts**—Teachers can now create their own podcasts for listening instruction and practice, but an even more innovative use for podcasts is assessment. Using *Audacity* or another free software tool, teachers can gather oral language samples from students. This use of podcasts gives teachers greater ease in assessing students’ individual speaking skills, using a rubric or checklist they design specifically for the task. Student-produced digital files can be stored in an online portfolio to assess

**FIGURE 2** Leapster Handheld Personal Learning Tools



Source: ©LeapFrog Enterprises, Inc. Used with permission.



Websites such as *Quia* allow teachers to design motivating practice tailored to specific languages and textbooks. Source to come.

© Shutterstock



Language labs make possible authentic practice, monitoring, and feedback. Source to come.

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progress over time and for students' reflection on their own progress.

- » **Translation websites and handheld translation devices**—A variety of websites and portable devices are available to aid translation from one language to another. All these aids are considered forms of machine translation (MT). (See the Hot Topic for Debate feature.) Popular translation websites are shown in Figure 1. Handheld devices make translation more accessible. For example, the Penpower WorldPenScan Pro shown in Figure 3 is a text scanner that is integrated with *Babylon* dictionary and translation software. Using this “pen,” students scan a word or phrase and get a spoken or written translation. The Lingo Talking Translator is another kind of handheld that provides on-the-spot translation (see Figure 4). Also look for free language learning communities and other free resources in the Open-Source Options feature.

**FIGURE 3** The WorldPenScan by *Penpower*



Source: Reprinted by permission of Penpower Technology Ltd.

**FIGURE 4** The Lingo Talking Translator by *Lingo Travel*



Source: Reprinted by permission of Lingo Corporation.

## Virtual Collaborations

Many teachers have found student collaborations to be effective in motivating students to use their emerging language skills. Using email, blogs, wikis, online chats, and other communication technologies, students can work with students of other cultures to provide authentic writing and research experiences. O'Dowd (2011) says that these exchanges are called **Blended Intercultural Telecollaborations**, or “international class-to-class partnerships in which projects and tasks are developed by the partner teachers in the collaborating institutions” (p. 3), and can be divided into three categories:

1. Information exchange tasks—Learners provide their long-distance partners information about their personal biographies or aspects of their home cultures.
2. Comparison and analysis tasks—In addition to requiring learners to exchange information, they also carry out comparisons or critical analyses of cultural products from each culture (e.g., books, surveys, films, newspaper articles).
3. Collaborative tasks—Learners are required to work together to produce a joint product or conclusion.

O'Dowd says, “The emphasis of these exchanges is on both developing cultural awareness and other aspects of intercultural communicative competence as well as linguistic competence” (p. 3). These collaborations are made possible when two teachers establish an email connection and begin an exchange of messages between their students. See sites such as the *ePals* Global Community, Global SchoolNet,

# Free open source **OPTIONS** for Free Software for ELL and FL Classrooms

## TYPES

## FREE SOURCES

### Free online practice and translation

*Brainpop ELL:* <http://www.brainpopesl.com>

*Google Language Tools:* [http://www.google.com/language\\_tools](http://www.google.com/language_tools)

*Multi-Language Words Memorizer:* <http://memorizer.codeplex.com>

### Free language learning websites and software

*Busuu Language Learning Community:* <http://www.busuu.com>

*LiveMocha Language Learning Community:* <http://www.livemocha.com>  
(free for initial period only)

*Hello-Hello Language Learning Community:* <http://hello-hello.com>

*BBC Audio-Video Courses:* <http://www.bbc.co.uk/languages>

*Byki Express:* <http://www.byki.com/fls/FLS.html>

### Blogs and wikis

*Blogger (now hosted by Google):* <http://www.blogger.com>

*Wikispaces:* <http://www.wikispaces.com>

and *The Mixxer* (Figure 5) for help on establishing contacts with distant students (see all site links in Table 1).

**FIGURE 5** *The Mixxer* Website



Source: Reprinted by permission of Todd Bryant, Dickinson College. <http://www.language-exchanges.org>.

## Virtual Field Trips for Modified Language Immersion Experience

Field trips provide a wealth of opportunities for language acquisition but are being greatly limited by funding. Virtual field trips provide opportunities for students to go places that would be impossible for them to see otherwise (Castleberry & Evers, 2010). There are several ways to implement virtual field trips. The most common virtual field trip format is a webquest-like format that has students visit websites, answer questions, and produce a product of some kind in the target language, such as a poster, brochure, or menu (see Technology Integration Example 1). Examples of virtual tour support sites include *InterLingo Spanish* and *Tramline* (see links for both in Table 1). Another kind of virtual field trip is when the teacher or a member of the class takes a field trip, video records it, and records running commentary to share with the class. The narrator strives to make sure that there is a good match between what is being viewed and what is being said, and the language can be in either English or the target language. There are also professionally produced virtual-reality field trips in which the user can “walk around” in the site by pressing various keys on the keyboard. Many of the world’s outstanding art museums have virtual tours of this kind.

As with any field trip, students should be prepared ahead of time for their experience, building background

**TECHNOLOGY INTEGRATION EXAMPLE 1****ELL OR FL VIRTUAL FIELD TRIPS****TITLE:** My Favorite Museum!**CONTENT AREA/TOPIC:** ELL or any major foreign language**GRADE LEVELS:** 7–12**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts**21ST CENTURY SKILLS:** World languages; Creativity and Innovation: Think creatively; Communication and Collaboration: Communicate clearly; ICT Literacy: Apply technology effectively**DESCRIPTION:** Students visit websites of two to four museums of a country in the target language. They answer questions about a museum of their choice, including: the name of the museum, telephone number, hours of operation, entrance fees, and some of the major artwork that can be found there. Using word processing software in the target language and images found on the website, they create a poster or brochure for the museum that includes the above information and images. Have them use an exchange rate website to determine the cost in U.S. dollars, as well as the country's currency, and include that information in the poster or brochure.**Source:** Based on a concept in the Museums, Museums, Museums! lesson plan by Carol Parris and Julie Pinzás at the California Teachers Language Association's (CTLA) lesson plan website: <http://www.cilta.net/lessons>.

knowledge, vocabulary, and expectations. The virtual field trip should be followed with activities that encourage students to use their experiences to practice their oral and written language.

## Support for Practice in Language Subskills

Many websites provide intense practice in specific language skills and vocabulary sets. (See sample links to these in Table 1.) Websites such as *English Zone*, *English Banana*, *English Online*, and *Tower of English* provide fun but in-depth practice in areas that often give students great difficulty. For FL teachers, websites allow students to practice speaking and writing the language. For example, the *Quia*

site allows teachers to design exercises tailored to specific languages and textbooks, and many such exercises are already available free to anyone. *Pinyin Practice* offers Chinese tones online, and *Kanji Practice* offers an opportunity to practice reading and writing Japanese kanji. Students can even do traditional Spanish grammar drills, but in a new and engaging way.

One value of these types of websites is that the exercises provide models of activities that can be used by teachers to create similar activities to correct common errors being made by the students or to incorporate vocabulary currently being studied in class. Whenever possible, teachers should have students read exercises aloud after completing them to promote the connection between written and oral modalities. This practice promotes balanced skill development. Apps are also available to add anytime-anywhere practice on handheld devices and smart phones (see the Mobile Apps for Education feature).

## Presentation Aids

Castleberry and Evers (2010) say that every FL classroom should have a DVD player so that teachers can display films in the target language with or without subtitles. “Visual media let students link spoken and written words to actions and images on the screen” (p. 202).

When students are asked to give oral presentations, they can use *PowerPoint* or *Keynote* software or homemade videos to assist them. Visuals, in addition to supporting the concepts being presented, help students using them learn valuable skills in making effective presentations. Visuals also help reduce students' stress and focus their presentations. The 2Learn website gives teachers links to lessons for interactive whiteboards (see Table 1).

In addition to the websites and programs available for creating good oral presentations, digital cameras and scanners can also help create visuals to make the presentations more understandable and interesting. Scanned or digital pictures can easily be imported into *PowerPoint* or *Keynote* slides and are very effective in supporting student learning. Many teachers of English learners have found it vital to create a file of images for use in their instruction. The slides can be alphabetized, grouped by topic, or organized in any other way that makes them accessible. The Internet serves as a valuable resource for photographs and other images to add to presentations.

## Support for Text Production



In FL learning, students need experience in the process of reading and writing the new language. Most standard word processing programs, such as Microsoft *Word*, offer support for producing and/or proofreading text in languages other than English. These programs also allow symbols to





# MOBILE APPS FOR EDUCATION

## ELL AND FL LEARNING

App Name	Description	Device
<p><i>Fluent English</i></p>  <p>By <b>Fluentizer</b></p>	<p>Fluent English gives practice understanding native English speakers and increases vocabulary. It works like an audio book reader and also provides translation for words that the user doesn't understand. For better learning, it also provides pronunciations of each word in several different voices.</p>	<p>Android</p>
<p><i>Spanish Flashcards</i></p>  <p>By <b>Declan Software</b></p>	<p>Over 3,800 Spanish words and phrases with native speaker audio. Every word includes a native speaker's audio recording. Flashcard review and exercises to aid memorization. Learning-list testing technique ensures word retention.</p>	<p>iPad and iPhone</p>

*Source:* App images reprinted by permission of <http://www.fluentizer.com> and <http://www.declan-software.com>. Declan Software—Serious Language Learning Tools.

be inserted (e.g., umlauted letters in German or accented letters in French). However, special programs can also be obtained for languages such as Chinese or Russian that require characters other than the standard English alphabet (see Table 1 for samples). In addition to the authentic use of language in creating journals, descriptions of experiences, oral reports, and research projects, word processing programs support correct usage with grammar checks, correct spelling (spell-checks), and reminders to employ good style (e.g., use active rather than passive voice). (See Technology Integration Example 2 for a sample classroom strategy that uses a word processing program and images from web-sites.) Spell checks and grammar checks are not foolproof, however, in any language. Students should always be encouraged to read their writing aloud and to listen for clues that corrections or refinements should be made.

A valuable addition to the writing process is inviting student authors to read their writing aloud to a small group or developing an audio file with a program like *Audacity* to be posted online while structuring opportunities for questions and comments. These processes provide opportunities for oral English practice and listening practice while also giving authors some ideas for revisions. The use of word processors allows the student-author to revise easily without rewriting by hand. The finished, printed copy of the text is also very motivational to the writer because it is very readable in typed, rather than in handwritten, form.

## Productivity and Lesson Design Support for Teachers

The Internet holds a wealth of resources to help ELL and FL teachers prepare for and carry out lessons. For example, the Intercultural Development Research Association offers a number of teaching resources and professional development opportunities. Some of these sites allow ELL teachers to network and share ideas and concerns. For FL teachers, a wealth of lesson and unit ideas can be found across the Internet on sites hosted by commercial and private groups and university programs. See Table 1 for samples of all these sites.

## TECH-PACK NEEDS AND CHALLENGES IN ELL AND FL LEARNING

Technologies have played an integral role in language learning for many years, but that role has greatly expanded in the last decade. Digital tools now offer many ways to expand opportunities for listening, speaking, reading, and writing in English and other languages. Communications technologies not only connect learners with useful and motivational materials, they also connect learners with each other. These

**TECHNOLOGY INTEGRATION EXAMPLE 2****SUPPORT FOR TEXT PRODUCTION****TITLE:** The ABCs of Learning (Language Name)!**CONTENT AREA/TOPIC:** ELL or any foreign language**GRADE LEVELS:** 5–8**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts**21ST CENTURY SKILLS:** World languages; Creativity and Innovation: Think creatively; Communication and Collaboration: Communicate clearly; ICT Literacy: Apply technology effectively**DESCRIPTION:** Students can work individually or in pairs and use a language-specific word processing program to create an alphabet book in the target language. They begin by looking up words for each letter on various websites. The teacher can give them some vocabulary sites to begin with, or they can locate their own. For each word, they put an oversized image of the letter, a word that begins with the letter, an image that represents the word, and one to three additional words that also begin with that letter. Encourage them to think creatively about how to display these elements on the page. They print the books or display them on a school website, along with the “author name(s).”**Source:** Based on a concept in the lesson plan by Joan Diez at the Lesson Plans Page website: <http://www.lessonplanspage.com>.

connections enable a more authentic environment and purpose for hearing and practicing languages.

As noted in the beginning of the “Issues and Problems...” section of this chapter, instructional needs for ELL and FL are different, so Tech-PACK needs and challenges for ELL and FL teachers also differ. For ELL teachers, the overall challenge is to find ways of applying technologies that can help address the needs of many differing students for whom English may be a second or even a third language and who may not be literate in any language. For FL teachers, the challenge is finding time to use technologies in ways that might enrich the learning experiences while making sure students meet criteria called for by state accountability measures.

These challenges are discussed here from the perspective of each of the separate Tech-PACK components. Finally, strategies for improving one’s Tech PPACK are given.

**ELL and FL Content Knowledge**

Languages change over time, so the content on which FL teachers must keep current is as changeable as the languages themselves. In addition, FL teachers must try to remain current on cultural content they must impart to their students, even though they may not have opportunities to go abroad for these updates. For ELL teachers, the content-related challenges are, in some ways, even greater. Many teachers are ELL teachers by default; they must be language teachers as well as expert teachers of their content. This means that they must know enough about the content of language learning to help bridge the gap in students’ language knowledge, and enough about the cultural backgrounds of their ELL students to understand the challenges that their students face and mistakes they are likely to make.

**ELL and FL Pedagogical Knowledge**

For FL teachers, pedagogies in language teaching have changed over the years, some as a result of new technologies. While the aim has always been to make students able to understand, speak, and write the language, the emphasis is now less on accomplishing these aims through oral recitations and practice of discrete skills. Language lab functions and capabilities have also changed. In addition to knowing how best to introduce language skills and motivate students to practice using the vocabulary and syntax, FL pedagogy must now include ways of giving students more authentic experiences with the languages and, when they have access to language labs, integrating the new lab capabilities. Since most students will not be able to have in-person encounters with native speakers of their target languages, “authentic experience” means learning how to implement virtual field trips, Blended Intercultural Telecollaborations, and computer-assisted language learning (CALL) into their teaching repertoires. To their usual standard assessments, teachers must also add cultural knowledge of countries that speak the target languages.

For ELL teachers, pedagogies focus on diagnosing (formally and informally) where students are in their English skill development and finding ways to scaffold them from where they are to where they need to be. With an increasing number of ELL students and with continuing calls for higher student achievement in content areas, teachers are compelled to learn new ways of teaching that simplify directions and find ways of working around students’ English limitations.

**ELL and FL Technological Knowledge**

Since technologies are now available to help meet content and pedagogical challenges of both FL and ELL teachers, both must become well acquainted with an array of new

digital tools and materials. Technologies for FL teachers include multimedia language labs, devices, and software; communications technologies, such as videoconferencing, blogs and wikis; presentation software tools; and language-specific word processing programs. Finally, they must become familiar with both language-specific websites and more general ones (e.g., *Tramline*) that can support instructional strategies. ELL teachers need to be able to use websites, software, and handheld devices that can help students with limited English proficiency.

## Strategies for Improving Tech-PACK in ELL and FL Teaching

Strategies to improving Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

- » Do I have the ELL and FL content knowledge I need to assist my students in meeting the standards within my classroom? For the language and cultural updates, FL teachers need to keep current in the languages and cultures of other countries—the same “intercultural tele-collaborations” and media used by their students can also benefit them. Communications technologies can also enable collaborations with other FL teachers in this country and native speakers in other countries.

- » Do I have the technological knowledge needed to teach the ELL and FL content within my classroom? To implement technology-enabled teaching strategies, teachers will have to learn a number of technologies that may be new to them. They will hear about these resources from their professional magazines and journals and from other teachers they encounter in person and online. But the expertise they need to use these tools themselves must come from hands-on professional development provided by their districts and by state and local professional organizations. They will have to search for workshops and conferences that focus on these tools and take advantage of the expertise of teachers they know who have already begun using these tools.
- » Do I have the pedagogical knowledge needed to teach the ELL and FL content within my classroom? Table 1 shows several sources of lesson plans to model how to integrate technologies most effectively into classroom studies. Several of these sites also have videos of educators talking about their best practices with digital tools.

As part of the summary at the end of this chapter, you will deconstruct a teacher’s Tech-PACK based on what you know of their knowledge and what must be learned to teach ELL and foreign languages effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone in your own content area.



## SUMMARY

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

### 1. Issues and Problems in ELL and Foreign Language Learning—

Each of these current issues has implications for how teachers can and should integrate technologies.

- » For ELL, these include: Demands on content area teachers, providing academic and language prerequisites for ELL learners, the need to differentiate instruction, and challenges of integrating the students’ native languages.
- » For FL, these include: The need for authentic materials and perspectives, and the need for creating audience and purpose.

### 2. Technology Integration Strategies for ELL and FL Learning—

Integration strategies offer support for: authentic oral language practice and assessment, virtual collaborations, virtual field trips for modified language immersion, support for practice in language subskills, presentation aids, support for text production, and productivity and lesson design support for teachers.

### 3. Tech-PACK Needs and Challenges in ELL and FL Learning—

To integrate technologies effectively, teachers must have a combination of ELL and/or FL content knowledge, pedagogical knowledge, and technological knowledge. Strategies for improving your Tech-PACK in these areas are given.



# ISSUES

## for Collaborative Discussion and Reflection

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

- 1.** Globalization and multicultural awareness are both concerns that make FL teaching and learning a critical need in 21st century classrooms. Yet K-12 language classes are in short supply due to economic constraints, such as teacher availability and too few students to justify hiring a teacher in every language students want to take. What are some possible technological solutions to this problem? What benefits and limitations/constraints of each solution have you located in your research?
- 2.** Though the numbers of non-native speakers of English in U.S. classrooms continue to grow, teachers often feel ill-equipped to address the needs of these students. What methods have you read about in this chapter and elsewhere that could help these teachers? What role could technology play in supplying professional development for these teachers?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:

- » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
    - » What are the objectives of the lesson plan?
    - » How will you assess your students' accomplishment of the objectives?
    - » What integration strategies are used in this lesson plan?
    - » How would you prepare the learning environment?
  - Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
  - Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
  - Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Ms. Hernandez is a Spanish language teacher with 18 years' experience in teaching the language to middle school students. While her students seem to enjoy her classes, she has always had difficulty getting her students to practice the language enough to achieve any degree of fluency. She likes the idea she has read about in her journals of doing a virtual collaboration with a Spanish-speaking class of students in a country in which Spanish is the native language. She is fairly used to using websites for vocabulary and skill practice, but has never attempted anything like this project.*

- Deconstruct Ms. Hernandez's Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

## 5. WHAT'S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the "What must be learned" column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



**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.

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# TEACHING AND LEARNING WITH TECHNOLOGY IN MATHEMATICS AND SCIENCE INSTRUCTION



# TEACHING AND LEARNING WITH TECHNOLOGY IN MATHEMATICS AND SCIENCE INSTRUCTION

America's economic destiny lies in innovation, technology, science and research. It is here that investments will pay off in strong economic growth and a bright future.

John Edward Porter, former Congressman and Chair of The Research! America Alliance (In USA Today article: "Reaction to the Gathering Storm U.S. science education report," 2010)

## o u t c o m e s

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

1. Recognize the implications for technology integration of each current issue faced by mathematics teachers.
2. Create key strategies for integrating technology into mathematics curricula.
3. Recognize the implications for technology integration of each current issue faced by science teachers.
4. Create key strategies for integrating technology into science curricula.
5. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to mathematics and science teachers.



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## key terms

computer algebra system (CAS)  
calculator-based laboratory (CBL)  
data loggers  
graphing calculator

hands-on/minds-on science  
interactive or dynamic geometry  
software  
probeware

virtual manipulative  
webcasts



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## TECHNOLOGY INTEGRATION IN ACTION: **HOT AND COLD DATA**

GRADE LEVELS: 6–8 • CONTENT AREA/TOPIC: Physics, mathematics • LENGTH OF TIME: Three weeks

### **PHASE 1** **ANALYSIS OF LEARNING** **AND TEACHING NEEDS**

#### **Step 1: Determine relative advantage.**

Ms. Belt and Mr. Alter, the physics and mathematics teachers, respectively, at Pinnacle High School, were excited about the new calculator-based laboratories (CBLs) that had just arrived. As they learned about how CBLs can “grab” temperature data and display it in graphs and spreadsheets, they realized that activities with CBLs provide a natural link between science and mathematics studies. Having students use CBLs would be an ideal way to give them hands-on insights into the relationship between these two important skill areas. They also agreed that CBL activities would address the ongoing challenge of making abstract science and math concepts more concrete and visual. Having students collect and analyze their own data, they felt, would give students authentic, hands-on application of these concepts. They decided that a unit on heating and cooling experiments would be a good first activity. Students could take temperature measurements with the CBL probes and then use mathematical procedures to graph and analyze the resulting data.

#### **Step 2: Assess Tech-PACK.**

**Content and Pedagogical Domains.** Ms. Belt was an experienced classroom teacher; she had been teaching physics and chemistry in various middle schools for 12 years. She took courses and attended workshops periodically to keep up on new content and strategies for teaching more effectively. Mr. Alter was older than Ms. Belt, but not as experienced in teaching; he had just



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switched careers from engineering to education and had been teaching at the middle school level for only three years. He knew the mathematics content very well, but he found that teaching was harder than he thought it would be. However, he and Ms. Belt had worked together on curriculum for the school, and he looked to her as a mentor.

**Technology Domain.** Both Ms. Belt and Mr. Alter were comfortable using various technology tools. Mr. Alter had used computers and graphing calculators in his previous career, and now used them with his students. But again, he found it very difficult to implement them beyond a very basic level. He assigned the calculators for doing practice problems in the classroom and for homework. Ms. Belt, on the other hand, was very effective at using technologies to enhance her teaching. Recently, she had started having her students work in small groups with online simulations and present their findings in their preferred media. Again, Mr. Alter felt he had a lot to learn from Ms. Belt's engaging approaches to using technologies. For both of them, CBLs were a new technology, but they had read a great deal about other teachers who had used them. They created this unit based on ones they had read about.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

The teachers decided they would assess student progress in four areas: CBL performance tasks, carrying out scientific experiments, interpreting data from experiments, and completing and reporting on scientific experiments. They decided on the following outcomes and objectives they hoped students would achieve and outlined assessment methods to measure students' performance on them:

- » **Outcome:** CBL procedures. **Objective:** Each student will score at least 85% on a performance test designed to measure competence with CBL procedures. **Assessment:** A checklist with points assigned for successful completion of each task.
- » **Outcome:** Completing and reporting on scientific experiments, with teacher assistance. **Objective:** All students demonstrate they can work in groups to carry out the steps in an assigned experiment and to write summaries of their findings by achieving a rubric score of at least 85% on their work. **Assessment:** A checklist with points assigned for each step done correctly; a rubric to assess the quality of written summaries.
- » **Outcome:** Interpreting data from experiments. **Objective:** All students will demonstrate the ability to review and interpret data derived from experiments by correctly answering at least eight of ten questions requiring data interpretation. **Assessment:** A mid-unit test in which each student reviews example charts and answers questions on how to interpret the data.
- » **Outcome:** Completing and reporting on scientific experiments, without teacher assistance. **Objective:** All students demonstrate they can replicate and interpret data from a CBL experiment by working in pairs to complete the required tasks without assistance. **Assessment:** A checklist with points assigned for each step done correctly; a rubric to assess the quality of written summaries.

## ISSUES AND PROBLEMS IN MATHEMATICS INSTRUCTION

Science and technology have a unique relationship. Technology supports science and science makes new technology possible. Both will play a critical role in our students' future. Thus, it is not surprising that efforts to reform teaching and learning in these two areas have been at the center of the national standards movement. Technology provides many opportunities to build students' conceptual knowledge

of mathematics and science as well as to connect their learning to problems found in our world. This section highlights current issues and problems in mathematics education that shape technology integration strategies for these areas.

### Accountability for Standards in Mathematics

*The Principles and Standards for School Mathematics*, released in 2000 by the National Council of Teachers of Mathematics (NCTM), serves as a primary resource and

#### Step 4: Design integration strategies.

The teachers decided to team-teach the unit to draw together even more the links between the two content areas. Working together, they designed the following sequence of activities:

- » **Week 1:** Introduce unit activities and CBLs, and provide hands-on practice. Introduce the unit with a *Consumer Reports*-type scenario. Makers of camp stoves each claim their product heats water faster than their competitors' do. The various stoves used three different fuels: white gas, kerosene, and butane. The students have to establish which manufacturer is correct and write up their findings for the *Consumer Reports (CR)* magazine. Show the YouTube videos: *Eureka! #20, Measuring Temperature*, and *Eureka! #21, Temperature vs. Heat*. Demonstrate how students can use the CBL to grab data and how it displays temperatures in graph form. Demonstrate how to calibrate a CBL and discuss how to interpret CBL data.
- » **Week 2:** To set the stage for the main experiment, have students carry out initial heating/cooling experiments and present findings. As Ms. Belt helps small groups prepare materials for the next set of experiments, Mr. Alter has students do individual performance checks on CBL procedures and provides additional instruction as needed. Each small group is assigned a heating/cooling experiment. For example, have them heat bolts of various sizes and add them to beakers of water. Ask, for example: does water temperature in a beaker increase more when two smaller metal bolts are added or when one large bolt is added? Each group completes its assigned experiment, answers the question, writes up its findings, and presents the findings to the class by inserting spreadsheet and graphed data into a *PowerPoint* presentation.
- » **Week 3:** Students carry out the final experiment in three large groups. Using camp stoves borrowed from a local sporting goods store, students use the CBLs to heat water to boiling. They go through the step-by-step procedures for hands-on experiments, write up their findings, and present them to the whole class. They hold a whole-class discussion to interpret results, and write up a summary for credit. Each group works with the data to explore linear, quadratic, and exponential

functions of graphed data. Finally, students work in pairs to answer questions on the meaning of the graphs. They do mathematical analyses and presentations; take final tests.

#### Step 5: Prepare instructional environment.

The teachers prepared the classroom by setting up beakers, hot plates, and CBLs. They got a local sporting goods store to loan them three different camp stoves for the experiments. They tested each of the CBLs and made sure they worked. They designed and copied each of the performance measures and made copies of lab sheets needed during the experiments. Finally, they bookmarked the YouTube sites with videos they wanted to show so they could get to them quickly.

### PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

#### Step 6: Analyze results.

At the end of the unit, the teachers reviewed the students' products and discussed how the unit had worked. Mr. Alter and Ms. Belt were happy with the overall performance of the class. They were impressed at how engaged students had become in using the CBLs to gather and analyze data. Perhaps most encouraging, two female students seemed especially excited by the work they had done on the scientific experiments; they asked the teachers to give them information on careers in science and mathematics.

#### Step 7: Make revisions.

The teachers concluded that this kind of multidisciplinary unit worked very well. They decided to plan other CBL experiments, to be carried out on a long-term basis and at locations outside the classroom.

**Source:** Based on concepts from: *The Heat is On! Using the Calculator-based laboratory to Integrate Math, Science, and Technology* by Joanne Caniglia and *Heat vs. Temperature: What's the Difference?* by Karen Campbell.

guide for all who make decisions that affect the mathematics education of students in pre-kindergarten through grade 12. Through this document, mathematics educators describe a vision of mathematics teaching and learning. Achieving this vision requires "solid mathematics curriculum, competent and knowledgeable teachers who can integrate instruction with assessment, education policies that enhance and support learning, classrooms with ready access to technology, and a commitment to both equity and excellence" (NCTM, 2000, p. 3). The Principles and Standards document calls for a common foundation of mathematics

to be learned by all students. Six principles address crucial issues fundamental to all school mathematics programs:

1. Equity
2. Curriculum
3. Teaching
4. Learning
5. Assessment
6. Technology

NCTM stresses that “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning. . . . The existence, versatility, and power of technology make it possible and necessary to reexamine what mathematics students should learn as well as how they can best learn it” (from the Executive Summary of NCTM Standards at <http://www.nctm.org/standards>). Also see the NCTM website for details on the ten mathematics standards for pre-kindergarten through grade 12. Five content standards include:

1. Numbers and Operations
2. Algebra, Geometry
3. Measurement
4. Data Analysis
5. Probability

Five process standards include:

1. Problem Solving
2. Reasoning and Proof
3. Communication
4. Connections
5. Representations

(All standards reprinted with permission from the *Principles and Standards for School Mathematics*, copyright 2000 by the National Council of Teachers of Mathematics.)

Through these principles and standards, NCTM provides guidance on how to prepare students for a society that requires mathematical knowledge for filling crucial economic, political, and scientific roles in a highly technological workplace.

## Challenges in Implementing the Principles and Standards for School Mathematics

Helping teachers change their teaching styles to meet the vision described in the NCTM standards is not an easy task. The standards seek a fundamental shift in the way many teachers work. Technology can serve as a catalyst to move teachers toward an instructional style that is more student-centered, active, and relevant to the world we live in. Technology also provides learners with the opportunity to visualize and make more concrete the generally abstract world of mathematics.

Research points to three implications for the selection and use of technology related to mathematics education.

1. Teachers should consider an appropriate combination of off- and on-computer activities.

2. They should consider technology as a mathematical tool rather than as a pedagogical tool.
3. They should view technology as a tool for developing student thinking.

One way to accomplish these goals is to use computer software and applications that can be extended for long periods of time across topics to engage students in meaningful problems and projects rather than providing a variety of applications with no internal coherence.

## Directed vs. Constructivist Teaching Strategies: Ongoing “Math Wars”

In Sparks’ 2010 article reporting results of studies of early math curricula, she observed that the “math wars” remain unresolved. That is, study results do not resolve the ongoing conflict between “those who believe math should be explicit and teacher-directed or those who favor student-centered learning—a more constructivist approach in which students forge conceptual understanding through group work, hands-on projects, or discussions with other students” (p. 11). Kinach (2010) says that recent brain research on how students learn mathematics favors teaching strategies that are more constructivist in nature, but the dispute is by no means resolved. Technologies are available to support either kind of method, but the approach teachers use to teach math definitely determines the kind of integration strategies they would consider appropriate. See the Hot Topic Debate feature for one of the “battles” in these “math wars.”

## TECHNOLOGY INTEGRATION STRATEGIES FOR MATHEMATICS INSTRUCTION

Technology resources have made possible a variety of teaching and learning strategies to help address the *Principles and Standards for School Mathematics*. This section describes those strategies, and Table 1 summarizes them and gives examples of some of the technology resources that make them possible. Table 1 also gives a list of websites of general use to mathematics teachers.

### Bridging the Gap Between Abstract and Concrete with Virtual Manipulatives

Physical manipulatives are real objects such as blocks, Cuisenaire rods, and coins. They are a mainstay of the

## DO CALCULATORS MEAN THE END OF MEMORIZING MATH FACTS?

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.

A 2002 article in *EducationWorld* (<http://www.educationworld.com>), "Educators Battle Over Calculator Use: Both Sides Claim

Casualties," describes a "philosophical war" between "the kill and drillers, dedicated to times tables and long division, preaching the gospel of repetition and memorization" and "fuzzy math reformers, preaching concept over content, insight over 'right.'" Between them: the most visible symbol of the continuing conflict—the classroom calculator." The article goes on to list the reasons for and against using calculators with young children. Does the ready availability of calculators in classrooms mean that children no longer need to spend time memorizing math facts and multiplication tables? What evidence can you cite that helps define an appropriate role for calculators with young children?

**TABLE 1** Summary of Technology Integration Strategies for Mathematics

Technology Integration Strategies	Benefits	Sample Resources and Activities
Bridging the gap between abstract and concrete with virtual manipulatives	<ul style="list-style-type: none"> <li>Helps make abstract mathematics concepts more concrete to young students</li> <li>Offers flexible environments that allow students to explore complex concepts</li> <li>Provides concrete representations of abstract concepts</li> </ul>	<ul style="list-style-type: none"> <li>National Library of Virtual Manipulatives <a href="http://nlvm.usu.edu/en/nav/vlibrary.html">http://nlvm.usu.edu/en/nav/vlibrary.html</a></li> </ul>
Allowing representation of mathematical principles	<ul style="list-style-type: none"> <li>Allows a visual depiction of abstract math concepts</li> <li>Gives students environments to explore conjectures and make discoveries about geometry concepts</li> </ul>	<ul style="list-style-type: none"> <li><i>Geometer's Sketchpad</i> <a href="http://www.keypress.com">http://www.keypress.com</a></li> <li><i>Maple</i> software <a href="http://www.maplesoft.com">http://www.maplesoft.com</a></li> <li><i>Derive</i> <a href="http://www.chartwellyorke.com/derive.html">http://www.chartwellyorke.com/derive.html</a></li> </ul>
Supporting mathematical problem solving	<ul style="list-style-type: none"> <li>Helps students gather data to use in problem solving</li> <li>Provides rich, motivating, problem-solving environments</li> <li>Gives students opportunities to apply mathematical knowledge and skills in authentic contexts</li> </ul>	<ul style="list-style-type: none"> <li><i>Geometer's Sketchpad</i> <a href="http://www.keypress.com">http://www.keypress.com</a></li> <li>Vernier data collection systems <a href="http://www.vernier.com">http://www.vernier.com</a></li> <li>Texas Instruments graphing calculators and CAS <a href="http://education.ti.com/educationportal">http://education.ti.com/educationportal</a></li> </ul>

*Continued*

**TABLE 1 Summary of Technology Integration Strategies for Mathematics (continued)**

Technology Integration Strategies	Benefits	Sample Resources and Activities
Implementing data-driven curricula	<ul style="list-style-type: none"> <li>• Provides easy access to many data sets</li> <li>• Provides real data and statistics to support investigations</li> <li>• Helps students develop skills in data analysis</li> <li>• Allows students to explore and present data in graphical form</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Fathom</i> <a href="http://www.keypress.com">http://www.keypress.com</a></li> <li>• Spreadsheets such as Microsoft <i>Excel</i></li> <li>• Data from the U.S. Census <a href="http://www.census.gov">http://www.census.gov</a></li> <li>• <i>SPSS</i> statistical software <a href="http://www.spss.com">http://www.spss.com</a></li> </ul>
Supporting math-related communications	<ul style="list-style-type: none"> <li>• Allows easy contact with math experts for help on math problems</li> <li>• Promotes social interaction and discussion of math topics</li> <li>• Allows teachers to connect with each other and exchange ideas</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Math Forum</i> at Drexel-Ask Dr. Math <a href="http://mathforum.org/dr/math">http://mathforum.org/dr/math</a></li> <li>• Student-developed websites</li> </ul>
Motivating skill building and practice	<ul style="list-style-type: none"> <li>• Provides motivating practice in foundation skills required for higher-level learning</li> <li>• Provides guided instruction in a structured learning environment</li> </ul>	<ul style="list-style-type: none"> <li>• Carnegie's <i>Cognitive Tutor</i> software <a href="http://www.carnegielearning.com">http://www.carnegielearning.com</a></li> <li>• Waterford's <i>Early Learning Series</i> <a href="http://www.waterford.org/products/early-learning">http://www.waterford.org/products/early-learning</a></li> <li>• PLATO's <i>Achieve Now</i> program <a href="http://www.plato.com/elementary-math/plato-achieve-now">http://www.plato.com/elementary-math/plato-achieve-now</a></li> <li>• Leapfrog's <i>Didj</i> <a href="http://www.leapfrog.com/gaming/didj">http://www.leapfrog.com/gaming/didj</a></li> </ul>
Other mathematics resource websites for teachers	<ul style="list-style-type: none"> <li>• Offers sources of information, lesson plans on mathematics topics</li> </ul>	<ul style="list-style-type: none"> <li>• National Council of Teachers of Mathematics <a href="http://www.nctm.org">http://www.nctm.org</a></li> <li>• <i>Math Forum</i> at Drexel-Internet Math Library <a href="http://mathforum.org/library">http://mathforum.org/library</a></li> <li>• Texas Instruments Resources for Educators <a href="http://education.ti.com/educationportal">http://education.ti.com/educationportal</a></li> <li>• <i>Math World</i> <a href="http://mathworld.wolfram.com">http://mathworld.wolfram.com</a></li> <li>• <i>PBS Mathline</i> <a href="http://www.pbs.org/teachers">http://www.pbs.org/teachers</a></li> </ul>

elementary school classroom because they help students bridge the conceptual distance between concrete and abstract mathematical concepts. **Virtual manipulatives** are replicas of real manipulatives that are accessed via the Internet and can be manipulated through a keyboard or other input device. According to Li and Ma (2010), research has found that virtual manipulatives have positive impact on both attitudes toward mathematics and student achievement. While these tools are mentioned most often for lessons at the elementary level, Lee and Chen (2010) also report that virtual manipulatives can improve high school students' attitudes toward mathematics. These simulated activities are popular because

they offer more flexibility than activities using actual objects in the way teachers can use them to illustrate concepts.

Sarama and Clements (2009) say that virtual manipulatives may actually be better than physical ones for young children who are learning to connect concrete and abstract number concepts. "Compared with their physical counterparts, computer representations may be more manageable, flexible, extensible, and 'clean' (i.e., free of potentially distracting features)" (p. 147). To support this assertion, they offer seven "affordances" or unique characteristics that virtual manipulatives have for supporting learning, along with research that supports each one.

**TECHNOLOGY INTEGRATION EXAMPLE 1****USING VIRTUAL MANIPULATIVES****TITLE:** Virtual Manipulatives Help Teach Platonic Solids**CONTENT AREA/TOPIC:** Mathematics, geometry**GRADE LEVELS:** Middle school**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 6—Technology Operations and Concepts**21ST CENTURY SKILLS:** Core subjects: Mathematics; Critical Thinking and Problem Solving: Make judgments and decisions; Information, Media, and Technology Skills: Apply technology effectively

**DESCRIPTION:** Use three 3-D manipulatives online at the National Center for Virtual Manipulatives (<http://nlvm.usu.edu>) to help students learn about the five Platonic solids. Introduce or reinforce the terms “vertices, edges, and faces” and review Euler’s formula. Encourage students to describe attributes of the five solids as they view them. For each form, let students use the virtual tools to rotate the form and color each of the planes. Have them count the edges, vertices, and faces. Then have them use Euler’s formula to confirm it holds for each solid. Follow up with student construction of other solids using clay or paper. Ask inquiry questions such as, “What is the minimum number of colors required if no two faces of the same color can share an edge? Which of the Platonic solids have faces that could reasonably be considered “opposite one another?”

**Source:** Based on a concept from instructor information at the National Library of Virtual Manipulatives at <http://nlvm.usu.edu>.

Rosen and Hoffman (2009) illustrate how real and virtual manipulatives can be used to enhance mathematics learning at the elementary level. Utah State University maintains a library of virtual manipulatives for all grade levels that are tied to each of the mathematics standards’ content strands. For examples of virtual manipulatives, see the websites listed in Table 1. Also see Technology Integration Example 1 for a lesson that uses these tools.

## Allowing Representation of Mathematical Principles

Mathematics is an abstract subject. Our understanding of mathematical ideas and concepts is closely tied to how we represent the abstractions of mathematics. To some, the concept of “five” is literally five objects (apples, pennies, and

so on); to others, it is the numeral 5; to the ancient Romans, it was represented by the numeral V. Technology has greatly enriched the way the abstractions of mathematics can be represented, and today students must learn mathematics using several representations: symbolic (with numerals, variables, equations, and so on), verbal (with words such as “What percent increase is needed to reach \$32,000?”), graphical (using two- or three-dimensional graphs), or numerical (using tables of numbers or spreadsheets). For each of these representations, technology resources have been developed to allow learners to explore mathematics within that representation—and to explore the interaction among representations. For example, Obara (2010a) says that students have a hard time visualizing three-dimensional solids; however, by using physical models in conjunction with appropriate software, they can develop the required spatial sense.

**Graphing calculators** are advanced calculators that can graph equations, as well as perform calculation functions involved in higher-level math and science problems (see a sample graphing calculator in Figure 1). Research has shown that these tools can improve students’ understanding of functions and graphs as well as the interconnections among the symbolic, graphical, and numerical representations of problems. Browning and Garza-Kling (2010) review four different ways to use graphing calculators: (1) collecting or generating raw data, (2) examining multiple cases, (3) providing immediate feedback, and (4) showing graphical and numerical displays. Without technology,

**FIGURE 1** TI-Nspire Graphing Calculator



Source: Image used with permission of Texas Instruments, Inc.





## ADAPTING FOR SPECIAL NEEDS

### Problem-Solving Aids, Simulations, and Games for Mathematics and Science

Some students with learning disabilities become discouraged in mathematics when they make mistakes in basic calculations involved in solving problems. In these cases, they lose sight of the overall purpose of inquiry and problem solving, and their experience with these subjects suffers. The tools described below offer support that can be provided to an individual student, or better yet, provided to the entire class to support their problem-solving efforts as they pursue big ideas.

- » **Google Calculator:** <http://www.google.com/intl/en/help/features.html#calculator>—Complete calculations quickly and easily right within the browser.
- » **Web Math:** <http://www.webmath.com>—Enter a problem and view the step-by-step procedure for how the answer is derived.
- » **Wolfram Alpha:** <http://www.wolframalpha.com>—A knowledge engine that not only computes simple and complex calculations, but also contains links to related problem sets as might be found in a search engine.

Marino, Tsurusaki, and Basham (2011) say that “appropriate technology-enhanced curricular materials, such as

simulation and gaming software, can help students with disabilities (SD) be successful in science. These products engage students in the learning process and are fun and easy to use” (p. 70). They recommend websites like the following that provide interactive, highly motivating science activities. They allow students to repeat experiments quickly and efficiently and help students manipulate complex data.

- » **Filament Games:** <http://www.filamentgames.com/gils>—With support from the Institute of Education Sciences (IES) in the U.S. Department of Education, this group is developing a series of middle school life science games informed by current evidence-based educational practices and the Universal Design for Learning framework. These materials are especially intended to meet the needs of students with learning disabilities and other reading difficulties.
- » **Explore Learning’s Gizmos:** <http://www.explorelearning.com>—This website offers over 450 highly interactive simulations for students in grades 3–12.

*Contributed by Dave Edyburn*

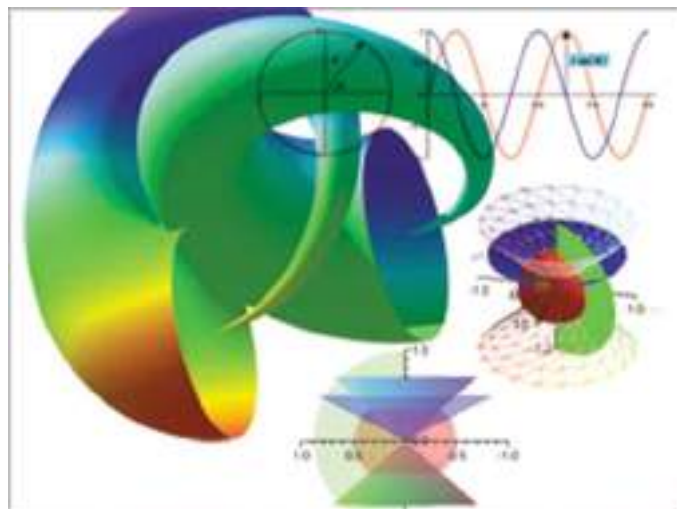
it is difficult, if not impossible, for students to move from the symbolic realm of  $f(x) = x^2 - 3$  to the equivalent graphical rendering on an x-y coordinate to its accompanying numerical representation.

A number of materials are designed to help students with special needs with calculations and other tasks involved in representing math concepts. See the Adapting for Special Needs feature to see some recommendations for selecting these.

In addition to calculators, many computer-based programs such as *Derive* (Chartwell-Yorke Ltd.) and *TI Interactive!* (Texas Instruments) provide learning environments across various mathematical realms. **Interactive or dynamic geometry software** refers to programs that allow users to create and manipulate geometric constructions. They provide students with an environment in which to make discoveries and conjectures related to geometry concepts and objects. Here abstract ideas can be played out on a computer screen, making concepts more real and providing a doorway into mathematical reasoning and proof. Internet resources also can help students make connections between abstract geometry and real objects in the world around them. Instead of memorizing geometric facts or concepts, students can explore proofs and arrive at conclusions on their own.

*Geometer’s Sketchpad* is among the most popular of these geometry programs (Graf, 2010; Muller, 2010; Obara, 2010b). Graf (2010) recommends using real manipulatives

#### FIGURE 2 Product of *Maple Algebra Software*



Source: *Maple* is a trademark of Waterloo Maple, Inc. Reprinted by permission.

first, followed by *Geometer's Sketchpad*. Obara (2010b) recommends both this tool and *Maple* computer algebra system (CAS) software. *Maple* is a multi-purpose **computer algebra system (CAS)**. A CAS can be either software or devices with software that help carry out complex numeric calculations involved in higher-level math problems. Maple has its own built-in programming language that is similar to Pascal and allows flexibility to design other algebra applications. See an example product from *Maple* in Figure 2.

Software capable of depicting solid or three-dimensional objects on a screen provides learners with a way to visualize objects that are difficult to imagine. Understanding the nature and properties of transformations and symmetry has become increasingly important and can be found in nearly all state mathematics standards. Bucher and Edwards (2011) and Garber and Picking (2010) recommend the free *GeoGebra* dynamic geometry software (shown with other free programs in the Open-Source Options feature) for this purpose.

## Supporting Mathematical Problem Solving

NCTM defines problem solving as “engaging in a task for which the solution method is not known in advance.” In order to find a solution, students must draw on their knowledge, and through this process, they will often develop new

mathematical understandings. The NCTM standards say that “solving problems is not only a goal of learning mathematics but also a major means of doing so.” Regardless of how many mathematical facts, skills, or procedures students learn, the true value of mathematics is realized only when they can apply their knowledge to solve problems. Technology, by its definition, is a tool for solving problems. To prepare mathematically powerful citizens for the future, learning to solve problems using mathematics and appropriate technological tools is essential to education at all levels.

As students acquire number sense, they can begin to make generalizations that lead them to concepts in algebra. Technology tools provide students with a variety of means for exploring the critical concept of functions. Using CAS or graphing calculators, students can graph functions accurately, explore mathematical models of real-life phenomena, and explore symbolic representations and patterns. **Calculator-based laboratories (CBLs, a.k.a. probeware)** provide a means to link either calculators or computers to scientific data-gathering instruments, such as thermometers or pH meters, which allow students to gather data and then analyze it. Probes are also available for handheld devices. Texas Instruments and Vernier, Inc. are companies that produce many of these tools and they often collaborate on products for both companies to market. See Figures 3 and 4 for examples of their products.

**Free**

open  
source

**OPTIONS**

for Free Software for Mathematics  
and Science Classrooms

### TYPES

### FREE SOURCES

**Free library of virtual manipulatives**

National Library of Virtual Manipulatives: <http://nlvm.usu.edu/en/nav/vlibrary.html>  
*Manipula Math* with Java: <http://www.ies.co.jp/math/java/index.html>

**Free online software**

*GeoGebra* geometry software: <http://www.geogebra.org>  
*Graph* mathematical graphing software: <http://www.padowan.dk/graph>  
*Mathomatic* computer algebra system: <http://www.mathomatic.org/math>  
Listing of free statistical software: <http://www.freestatistics.info/en>

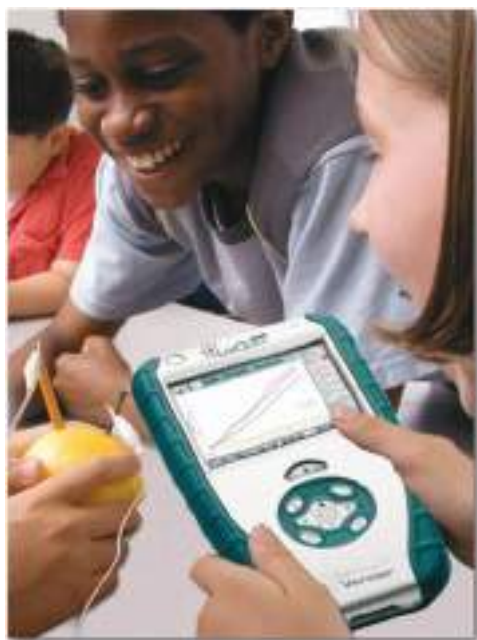
**Free science tutorials and games**

*Sheppard Software*: <http://www.sheppardsoftware.com/science.htm>

**Free videos and books**

YouTube science videos, for example: *Eureka! #20, Measuring Temperature* and *Eureka! #21, Temperature vs. Heat*  
National Academy Press (NAP): <http://www.nap.edu>

### FIGURE 3 Sample Vernier *Labquest* Probeware System



Source: Photo courtesy of Vernier Software & Technology.

### FIGURE 4 Texas Instruments TI-Nspire Handheld Data Collection System



Source: Image used with permission of Texas Instruments, Inc.

Although data-collection devices are available for purchase, Sory, Willard, and Kim (2010) describe a lesson in which students create their own low-cost digital thermometers and use a graphing calculator to calibrate them. Doe (2009) points out that handheld devices like mobile phones

make technologies such as probeware an even more versatile tool for problem-solving lessons.

Finally, spreadsheets have long been considered a powerful means of supporting problem-solving exercises. Niess, Sadri, and Lee (2008) say that “spreadsheets can help students make mathematical connections with problems in the world around them” (p. 423).

## Implementing Data-Driven Curricula

The importance of statistical inference and probability has already had an impact in U.S. schools. Technology provides an ideal means of developing student knowledge and skill related to data analysis. *Fathom* is a comprehensive package designed for schools that helps analyze and represent statistical data in a wide range of forms. Edwards and Phelps (2008) describe how *Fathom* can help students explore common geometry and algebra topics, and Shafer (2010) illustrates its use in teaching hypothesis testing.

Computer spreadsheets also provide environments in which children can explore number concepts, operations, and patterns with data they obtain from various sources. Students can work with basic operations, explore “what if” problems, and build a foundation for algebraic thinking. Spreadsheets can facilitate activities such as planning a fund-raising activity or analyzing data from students’ counts of colors in a bag of M&Ms or other candies; both are much-used strategies for helping to build students’ number sense. Students at later grade levels often use statistical software, such as *SPSS*, for this purpose. From sites such as the U.S. Census Bureau, students can download sample data sets to use in their math explorations.

## Supporting Math-Related Communications

Expressing numerical ideas in textual form is essential; therefore, students must be able to convert their mathematical thinking into words. Projects such as those found at the *Math Forum @ Drexel’s Problems of the Week* allow teachers to pose problems that their students must solve and then communicate about. Ask Dr. Math (also on the *Math Forum*) lets students contact math experts who can answer a question (see Figure 5).

Student-created websites can be a valuable form of communication for student projects. Using computers and calculators in small-group settings also promotes social interaction and discourse. Teachers often find that

## FIGURE 5 The Math Forum @ Drexel's Ask Dr. Math



Source: Reproduced with permission from Drexel University, copyright 2011 by The Math Forum @ Drexel. All rights reserved.

grouping students in pairs enhances learning, augmenting communication from teacher-to-student or computer-to-student to a richer student-to-student-to-computer type of communication.

## Motivating Skill Building and Practice

Computer-based tutoring systems for mathematics have been available for some time. One such product, called *Cognitive Tutor*, developed by professors at the Carnegie Mellon University, has been adopted in over 2,600 schools throughout the country (Bhattacharjee, 2009).

Although the current emphasis in mathematics instruction is on learning higher order mathematics skills, students often need more resources to support the practice of basic skills. These skills provide an important foundation on which they can build more advanced skills. Some technology resources that can support this practice are listed in Table 1.

## ISSUES AND PROBLEMS IN SCIENCE INSTRUCTION

### Accountability for Standards in Science

The National Science Education Standards (NSES), published in 1996 by the National Research Council (NRC), outlines the content that all students should know and be able to do; it also provides guidelines for assessing student learning in science. The NSES provides guidance for science teaching strategies, science teacher professional development, and the support necessary to deliver high-quality science education. The NSES also describes the policies to bring coordination, consistency, and coherence to science education programs. Many of the state standards documents have drawn their content from the *Benchmarks for Science Literacy*, published by the influential American Association for the Advancement of Science (AAAS), and/or the NSES. According to the NRC's website, the framework for these standards was revised in 2011 and will likely have an impact on the NCES.

The U.S. Department of Education and the National Science Foundation endorse mathematics and science curricula that “promote active learning, inquiry, problem solving, cooperative learning, and other instructional methods that motivate students” (NRC, 1996). Similarly, the National Committee on Science Education Standards and Assessment stated that “school science education must reflect science as it is practiced,” and that one goal of science education is “to prepare students who understand the modes of reasoning of scientific inquiry and can use them” (NRC, 1996). The basis for inquiry-oriented science instruction is developing varied opportunities for students to learn science process skills, such as collecting, sorting, and cataloging; observing, note taking, and sketching; and interviewing, polling, and surveying. In addition, research shows that inquiry-related teaching is effective in developing scientific literacy and the understanding of science processes, vocabulary knowledge, conceptual understanding, critical thinking, positive attitudes toward science, and construction of logico-mathematical knowledge.

Technology can play an important and integral role in inquiry-oriented science instruction. Harris and Rooks (2010) find that “in many inquiry-based classrooms, students are using innovative technology tools and resources such as Internet search engines and databases, model building software, handheld technologies, and a wide array of data collection and communication tools to engage in real-world investigations and communicate findings. Increasingly,

students are using the same technology tools that are used by practicing scientists” (p. 144). Owston (2009) also found an important role for technology in science inquiry learning in programs that sought to improve mathematics and science teaching at the high school, middle school, and upper elementary levels: all “emphasized teachers’ use of student-centered, inquiry-based approaches in their classrooms that involved all students regardless of ability. All made use of Web 2.0 technologies, such as blogs, webcasting, podcasting, and live video sessions” (p. 271).

To integrate technology in the science classroom on a regular basis, one must understand the meaning of technology in the context of science teaching and learning. The NSES provide a frequently mentioned definition of technology: “The central distinguishing characteristic between science and technology is a difference in goal: the goal of science is to understand the natural world, and the goal of technology is to make modifications in the world to meet human needs. Technology as a design is included in the Standards as parallel to science as inquiry” (NRC, 1996, p. 24).

## The Narrowing Pipeline of Scientific Talent

For years now, great concern has grown about America’s ability to compete in science, mathematics, and technology in the future. With the declining number of students—especially female and minority students—pursuing studies in the math, science, and engineering fields, America faces a growing crisis in leadership for much-needed science/technology/engineering/mathematics (STEM) initiatives. This trend could have serious consequences for the long-term economic and national security of our country. One of the first reports on the issue was presented by EMC Corporation’s (2003) *Fueling the Pipeline: Attracting and Educating Math and Science Students*. Since the publication of this seminal report, other organizations—both private and public—have continued to explore the problem. Bayer’s Facts of Science Education survey (2010) and the 2011 report by the Committee on Science, Engineering, and Public Policy (COSEPUP) confirm this is an ongoing issue.

## Increasing Need for Scientific Literacy

As the science benchmarks and standards reflect, there is a need for all citizens to be scientifically literate in order to make informed decisions that affect our country’s future. More than ever before, America’s economic and environmental progress depends on the character and quality of the science education that the nation’s schools provide.

## Difficulties in Teaching K–8 Science

Science is a rapidly changing area, and teachers are constantly challenged to keep up with new developments in science content, tools, and methods. Elementary education teachers face an even greater challenge, since they are typically required to have much less initial preparation in mathematics and science content than secondary science teachers. As a result, teaching science for understanding at an early level becomes difficult due to teachers’ lack of deep understanding of the discipline. One way to assist teachers in science is through increased professional development (PD). Online PD opportunities increase access for elementary teachers to this important area. For example, the Annenberg Foundation offers a collection of materials that can be used for a distance-education science PD program (see Distance Learning at <http://www.learner.org>). Moreno and Erdmann (2010) offer BioEd Online ([www.bioedonline.org](http://www.bioedonline.org)) and K8 Science ([www.k8science.org](http://www.k8science.org)), both developed by Baylor College of Medicine (BCM) as online PD to address teachers’ needs for “accurate, timely science information and teaching materials” (p. 1589). Finally, in a July 2011 issue of *Science & Children*, the National Science Teachers Association addressed this important need and offered both sources and criteria for effective professional development for elementary teachers. Also see the Adapting for Special Needs feature to see some recommendations for selecting science materials for students with disabilities.

## Objections to Virtual Science Labs

When science reform efforts began taking shape in the early 1990s, the American Association for the Advancement of Science called on teachers and schools to engage students in doing science rather than just hearing about it or seeing a demonstration. “Hands-on/minds-on” science (<http://handsonmindson.org>) became a common term in science reform, synonymous with immersing students in authentic learning experiences. According to Haury and Rillero (1994), Karen Worth, noted science reformer, defines **hands-on/minds-on science** as “engaging in in-depth investigations with objects, materials, phenomena, and ideas and drawing meaning and understanding from those experiences.”

Virtual schools, among others, have proposed that simulated labs for activities such as experiments with chemical compounds and animal dissections in biology are very much in keeping with the idea of hands-on learning. They maintain that students can spend more time focusing on the “science” of the activities when danger and sensory unpleasantness are removed. However, the National Science Teachers Association

(2007) and the American Chemical Society (2008) take issue with this view, saying that “hands-on” means that students must touch the materials rather than “do” science on a computer. Both organizations have issued position statements arguing against the acceptance of computer simulations as a substitute for real-life laboratory experiences.

At this writing, the College Board requires virtual schools and others who provide distance education courses in biology and chemistry to provide school-lab experiences in order to retain its endorsement as an Advance Placement (AP) course. This policy is under review pending sufficient research comparing learning outcomes from simulated and lab experiences. At this time, research results are inconsistent. For example, in their study comparing learning from simulated and in-person frog dissection, Akpan and Strayer (2010) found that the simulation group had higher achievement gains and better attitudes than the group that did a conventional dissection. But they note that these results contradict results of past studies. Clearly, this is an area in need of further research.

## TECHNOLOGY INTEGRATION STRATEGIES FOR SCIENCE INSTRUCTION

Technology resources support many kinds of teaching and learning strategies to help address science standards. Table 2 summarizes these strategies and gives examples of some of the technology resources that make them possible.

### Involving Students in Scientific Inquiry Through Authentic Online Projects

Authentic science not only involves having students “do” science, it also includes connecting science to students’ lives and life experiences. Involving students in active scientific investigations can improve their attitude toward science as well as their understanding of scientific concepts. Some online projects are available that can engage students by making them partners in scientific investigations. These projects give them experience with all aspects of the scientific approach: asking new and novel questions, setting up researchable hypotheses, collecting and analyzing data, communicating the results, and getting feedback to help interpret and refine results. Scientists use a variety of technologies in their own work, and these projects use many of the same tools to teach the scientific process. Three such projects are: the Global Learning and Observations to Benefit the Environment (GLOBE) Program, Project FeederWatch, and Journey North.

The GLOBE Program is an excellent example of this kind of all-purpose project. GLOBE is an environmental science project that has students investigate the weather, land cover, soil, and hydrology, and record their observations at the GLOBE site. In effect, they become collaborators in a real scientific investigation.

First, they take ground observations using state-of-the-art technologies such as temperature **data loggers**, which are devices that record data over time with sensors, and global positioning systems (GPS), as well as traditional technologies such as a weather shelter and a U-tube thermometer. They record their data in a notebook and enter it into a database at the GLOBE site. Then they manipulate data with online graphing and visualization tools. The data can also be displayed in a graphical form, allowing students to look for patterns over time. To complete the process, students write up their results and post them to the GLOBE Student Research website. In the write-up, students report on their research questions, discuss their procedures, communicate their results using graphs and charts, and make conclusions. Once posted on the website, the report is peer reviewed by GLOBE participants.

Another such multipurpose site that involves students in real scientific investigations is Project FeederWatch from Cornell University, which provides teachers with a bird identification key and instructions for stocking a bird feeder, gathering data, and submitting the information to the site. This project provides numerous opportunities for using spreadsheet data and carrying out geographic information system analyses.

Finally, Journey North projects connect students and scientists in real-life science research. The project identifies itself as the “citizen science” project for children. It engages students in a global study of wildlife migration and seasonal change. K–12 students share their own field observations with classmates across North America. They track the coming of spring through the migration patterns of monarch butterflies, robins, hummingbirds, whooping cranes, gray whales, bald eagles, and other birds and mammals; the budding of plants; changing sunlight; and other natural events. The database they help create can be used to study factors such as climate change, migration, and soil and water conditions. All Journey projects correlate directly to National Science Education Standards, with an emphasis on science inquiry. The site also offers teachers dozens of lesson plans and activities to use with their students.

### Support for Specific Processes in Scientific Inquiry

Teachers do not always have time to commit to long-term projects that encompass the entire scientific process.

**TABLE 2** Summary of Technology Integration Strategies for Science

Technology Integration Strategies	Benefits	Sample Resources and Activities
Involving students in scientific inquiry through authentic online projects	<ul style="list-style-type: none"> <li>Internet projects provide environments that support all phases of an authentic science experience</li> </ul>	<ul style="list-style-type: none"> <li><i>Globe Project</i>: GLOBE Program: <a href="http://globe.gov">http://globe.gov</a></li> <li><i>Journey North</i>: <a href="http://www.learner.org/jnorth">http://www.learner.org/jnorth</a></li> <li><i>Project FeederWatch</i>: <a href="http://www.birds.cornell.edu/pfw">http://www.birds.cornell.edu/pfw</a></li> </ul>
Support for specific processes in scientific inquiry	<ul style="list-style-type: none"> <li>Helps students locate and obtain information to support inquiry</li> <li>Makes data collection and analysis more manageable</li> <li>Makes phenomena easier to visualize and understand</li> <li>Helps students communicate results of inquiries</li> </ul>	<ul style="list-style-type: none"> <li>CBLs and spreadsheets</li> <li>The Exploratorium Museum: <a href="http://www.exploratorium.edu">http://www.exploratorium.edu</a></li> <li>National Science Digital Library (NSDL): <a href="http://nsdl.org">http://nsdl.org</a></li> <li>Digital Library for Earth System Education: <a href="http://www.dlese.org/library">http://www.dlese.org/library</a></li> <li>PhET Independent Simulations: <a href="http://phet.colorado.edu">http://phet.colorado.edu</a></li> <li>ReciprocalNet: <a href="http://www.reciprocalnet.org">http://www.reciprocalnet.org</a></li> </ul>
Supporting science skills and concept learning	<ul style="list-style-type: none"> <li>Allows students to simulate and model various scientific processes</li> <li>Provides opportunities to engage in problem solving</li> </ul>	<ul style="list-style-type: none"> <li>Poll Everywhere text message polling service (students use their cell phones as "clicker" devices): <a href="http://www.polleverywhere.com">http://www.polleverywhere.com</a></li> </ul>
Engaging students in engineering topics through robotics	<ul style="list-style-type: none"> <li>Gives students experience with engineering principles</li> <li>Gets students thinking about engineering careers</li> </ul>	<ul style="list-style-type: none"> <li>NASA's Robotics Alliance project: <a href="http://robotics.nasa.gov">http://robotics.nasa.gov</a></li> <li>International Technology and Engineering Educators Association: <a href="http://www.iteaconnect.org">http://www.iteaconnect.org</a></li> </ul>
Accessing science information and tools	<ul style="list-style-type: none"> <li>Offers sources of information, lesson plans on science topics</li> </ul>	<ul style="list-style-type: none"> <li>National Academy Press (NAP): <a href="http://www.nap.edu">http://www.nap.edu</a></li> <li>Telescopes that educators and students may use: <ul style="list-style-type: none"> <li>Telescopes in Education: <a href="http://www.telescopesineducation.com">http://www.telescopesineducation.com</a></li> <li>British telescope system with observatories in Hawaii and Australia: <a href="http://www.faulkes-telescope.com/aboutus">http://www.faulkes-telescope.com/aboutus</a></li> <li>National Optical Astronomy Observatory: <a href="http://www.noao.edu/education/arbse/top">http://www.noao.edu/education/arbse/top</a></li> <li>Bradford robotic telescope in Canary Islands: <a href="http://www.telescope.org">http://www.telescope.org</a></li> <li>San Diego Astronomy Association: <a href="http://sdaa.org">http://sdaa.org</a></li> </ul> </li> <li>Night Skies Network for amateur astronomers: <a href="http://www.nightskiesnetwork.com">http://www.nightskiesnetwork.com</a></li> </ul>
Other science resource websites for teachers	<ul style="list-style-type: none"> <li>Offers sources of information, lesson plans on science topics</li> </ul>	<ul style="list-style-type: none"> <li>National Science Education Standards: <a href="http://www.nap.edu">http://www.nap.edu</a></li> <li>National Science Teachers Association (NSTA): <a href="http://www.nsta.org">http://www.nsta.org</a></li> <li>American Association for the Advancement of Science (AAAS): <a href="http://www.aaas.org">http://www.aaas.org</a></li> <li>National Aeronautical and Space Administration (NASA): <a href="http://www.nasa.gov">http://www.nasa.gov</a></li> <li>National Science Education Standards: <a href="http://www.project2061.org">http://www.project2061.org</a></li> <li>National Oceanic and Atmospheric Administration (NOAA): <a href="http://www.noaa.gov">http://www.noaa.gov</a></li> </ul>

However, various technologies can provide support for specific elements of the scientific inquiry process. Some of these are described here. Also see Technology Integration Example 2 for an illustration of these principles in action.

**Locating information to investigate scientific issues and questions.** The Internet has become an indispensable tool for investigating important scientific questions. Science teachers and students have access to a number of exciting resources for teaching and learning science. For many of the science areas, teachers and students can access information from sources, such as NASA, or museums, such as the Exploratorium (see Figure 6).

The National Science Foundation (NSF) has funded the creation of digital libraries for science topics, as well as an online portal to education and research on learning in STEM topics called the National Science Digital Library (NSDL). One of the NSF-funded libraries is the Digital Library for Earth System Education (DLESE). The DLESE is a community of educators, students, and scientists working to improve the teaching of and learning about the Earth system at all levels. DLESE provides access to a number of collections of educational and scientific resources. Digital libraries provide a starting point for the investigation of scientific questions.

**Collecting data.** Data collection and archiving are important parts of the scientific inquiry process. Science bases its conclusions on data, and a number of tools are available for students' data collection and archiving. The calculator or computer-based laboratory (CBL or probeware) is an ideal tool for middle school through high school science. CBL sensors collect data, and the data can be downloaded into a computer or calculator and then manipulated in a spreadsheet. By archiving data in a spreadsheet, the data can be used at another time or compiled for long-term investigations. Using today's tools, students do not even have to be in the same location as the data being collected. They can collect data from remote sensors or from webcams set up to observe phenomena. Quillen (2011) describes one such activity where students operate a Geiger counter in Queensland, Australia, to measure how the intensity of radiation changes with distance.

**Visualizing data and phenomena.** A number of visualization tools exist that allow students to see representations of data and phenomena that may be difficult to observe directly. These include simulations that help students see illustrations of (1) macroscopic phenomena, such as the phases of the moon or butterfly metamorphoses, which usually occur too slowly to observe processes, or (2) microscopic

## TECHNOLOGY INTEGRATION EXAMPLE 2

### SUPPORTING SCIENTIFIC INQUIRY SKILLS

**TITLE:** Think Before You Drink!

**CONTENT AREA/TOPIC:** Science

**GRADE LEVELS:** 4–6

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subject: Science; Critical Thinking and Problem Solving: Solve problems; Communication and Collaboration: Communicate with others, communicate clearly; ICT Literacy: Apply technology effectively

**DESCRIPTION:** Students work in small groups to gather water samples from various locations that have consumable drinking water and make predictions about whether they are safe to drink. They use probeware to gather data on various aspects of water quality and enter the data into a spreadsheet for analysis. Each group presents results in a *PowerPoint* presentation to the rest of the class. If any water proves to be unsafe or of questionable quality, the students work as a whole class on a letter to the business or city about what needs to be changed to improve the water quality.

**Source:** Based on a concept in the Vernier lesson plan by Erin Van Lue, Lesley Drinkwine, and Mark Alexander at <http://www.nd.edu/~nismec/vernier.htm>.

**FIGURE 6** Exploratorium Website



Source: © Exploratorium, [www.exploratorium.edu](http://www.exploratorium.edu). Reprinted by permission.



or other phenomena that would otherwise be difficult or impossible to observe, for example, molecular structure or parts of cells. In the past, students have learned from images or sped-up videos of some of these phenomena. Computer simulations differ from illustrations or videos in that students can manipulate elements in them and see the result. One resource for simulations is the Physics Education Technology (PhET) Independent Simulations project at the University of Colorado at Boulder. It offers more than 100 models to teach concepts in physics, chemistry, biology, and calculus; all are free for teachers' and students' use (Quillen, 2011).

Modeling tools make it possible to rotate and examine structures from multiple viewpoints to help students understand them. These tools also emulate the way scientists work in real environments. For example, meteorologists regularly show computer-generated visualizations on television to help explain weather phenomena. City planners use GIS modeling to plot population growth. One such modeling tool for use in physics is *ReciprocalNet*. It offers a digital collection of molecular structures, as well as software tools for visualizing, interacting with, and rendering printable images of the structures.

**Analyzing data.** Analyzing data can be done with a number of existing programs that come standard on computers. Spreadsheets allow data to be entered and analyzed using simple statistics or algorithms supplied by the students. In the GLOBE project, *MultiSpec* software provides students with the ability to identify land cover types on a LandSat image. GIS software allows students to analyze factors in an image by removing or adding attributes and looking for connections among attributes.

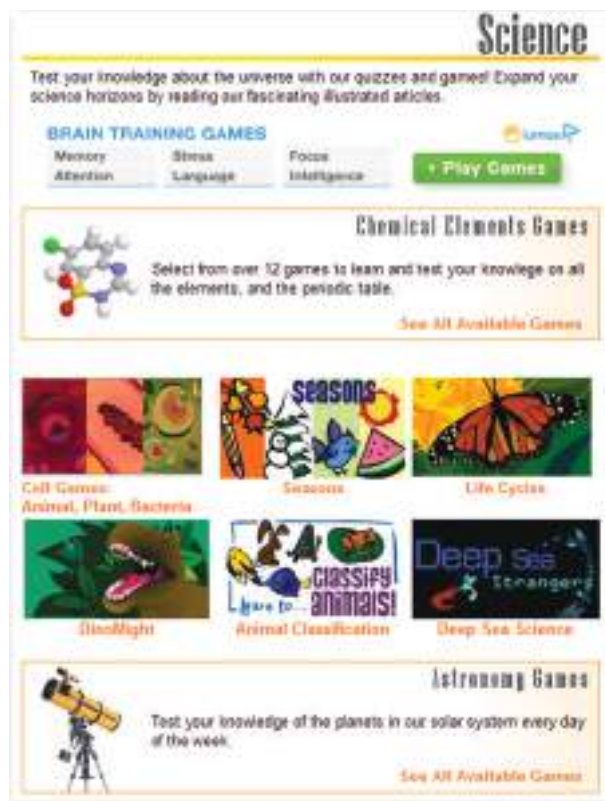
**Communicating results.** Once data are analyzed, scientists write up the results and submit them for publication using standard productivity software (e.g., word processing). Scientists collaborate on scientific problems, and the Internet facilitates the communication process. In addition to graphs and visualizations, scientists use images from digital cameras and other digital instruments to record data and compare and contrast data over time. This is especially useful in land cover investigations and in astronomy. The Internet also provides a medium for communication among scientists. Data can be emailed to researchers around the globe. Classroom teachers can also have scientists interact with students in their classroom via email, blogs, or by participating in **webcasts**, which are live video broadcasts of an event sent over the Internet.

## Supporting Science Skills and Concept Learning

Though hands-on science remains the major science instructional strategy, online science lessons and games can provide motivational ways to supplement this instruction. For example, Sheppard Software has well-designed, free science tutorials and games (see Figure 7 for samples of these games, and the Open-Source feature for a link to their site). A search for “science games” yields a number of other good activities.

Tremblay (2010) discusses an innovative way to check students' concept learning after a science lesson by turning students' cell phones into student response systems (SRS, a.k.a., clickers). The teacher sets up a set of questions over lesson content in an online survey format on the Poll Everywhere (PE) website. Students respond to the questions by sending a text message from their cell phone to the number provided by the PE service or by going to the PE website using the browser on their phone. As answers come in, the website also updates a graph showing the number of responses to each option.

**FIGURE 7** Sheppard Software's Science Website



Source: <http://www.sheppardsoftware.com>. Reprinted by permission.

## Engaging Students in Engineering Topics through Robotics

Technology and engineering topics are often called “the missing T and E” in STEM education. One wry observer said that in STEM, the “T is lowercase and the E is silent” (<http://creatingthefuturetoday.com/pages/135>). In fact, the lack of emphasis on these important areas was the driving force behind the International Technology Education Association (ITEA) changing its name to the International Technology and Engineering Educators Association in 2010 (ITEA officially becomes ITEEA, 2010).

The ITEEA has information and publications at its website on how to combine and emphasize these topics. One of these ways is through robotics curriculum, which has become an increasingly popular strategy for engaging students in problem solving and getting them interested in engineering principles and careers. Nugent, Barker, Grandgenett, and Adamchuk (2010) found that an intensive 40-hour robotics/GPS/GIS camp had great impact on students’ learning of science content, but even a three-hour experience modeled on the same camp had great effect on improved attitudes toward science and technology and made kids excited about learning more.

Robotics camps and competitions sponsored by companies, universities, and professional organizations are plentiful; an Internet search under “robotics competitions” lists events at every grade level and region of the country. Many schools sponsor students to prepare products to enter in robotics competitions as a part of their science curriculum. The focus of competitions varies: some set a common problem for all participants and ask for innovative design solutions (e.g., build an electric car), while others set general goals and ask participants to come up with their own

innovative products. The number of these contests speaks to their perceived impact on generating student interest in STEM content. NASA provides information on these contests, as well as a collection of robotics information and materials at its website.

## Accessing Science Information and Tools


The Internet has opened up a world of tools and materials for use by teachers and students. One example of the opportunities provided by these unique tools is the ability for teachers and students to get time to use a remote online telescope to carry out various investigations. A few of the remote telescopes are given in Table 2 with their URLs.

The Internet is also an unlimited source of data for classroom experiments and investigations, camps and competitions, and up-to-date science information. Science knowledge changes faster than most school libraries can keep up. For the latest information on space, students can access NASA; for the weather, NOAA; for medicine, the NIH. Most of these sites provide content targeted for teachers and students. As of June 2011, anyone can download new publications from the National Academy Press (NAP) website free of charge. The NAP has a wide variety of current, useful publications in science and science education. Teachers can also use the Internet for assistance with content knowledge and for professional development opportunities that may not be available locally. They can also exchange ideas and teaching strategies with other teachers in learning communities. See a general list of helpful information sources under Other Science Resource Websites in Table 2. Also see the Mobile Apps for Education feature for a way to access important science information from any location.



# MOBILE APPS FOR EDUCATION

## MATHEMATICS AND SCIENCE INSTRUCTION

App Name	Description	Device
NASA App HD  From NASA.gov	Thousands of images from NASA IOTD, APOD, and NASAImages.org; on demand NASA videos from around the agency; live streaming of NASA TV; current NASA mission information; launch information and countdown clocks; current visible passes for the International Space Station (ISS) and Earth Orbiting Satellite Tracker; NASA Twitter Feeds from around the agency; Facebook Connect and Integrated Twitter client for easy sharing; map and links to all of the NASA centers; quick links to the NASA topic areas; and featured content section.	iPad

## TECH-PACK NEEDS AND CHALLENGES IN MATHEMATICS AND SCIENCE INSTRUCTION

Technologies are an integral part of modern mathematics education and science education because they are essential in the field themselves. Today's scientists and mathematicians (and fields like engineering and medicine, which use math heavily) cannot do their jobs without technology tools. Science education standards were re-conceptualized when this fact became apparent; students cannot learn science in any meaningful way unless they use the tools of science. For example, a science teacher cannot simply lecture about data collection or just demonstrate it; instead, the standards require that students carry out their own data collection.

The same holds true for mathematics learning. When teaching a mathematical concept, such as slope and y-intercept, teachers do not simply demonstrate how to do problems and have students draw graphs; instead they have students enter data into graphics calculators and help them interpret the output. Learning which tools to use and how to teach most effectively with them is the challenge that both mathematics and science teachers face. These challenges are discussed here from the perspective of each of the separate Tech-PACK components. Finally, strategies for improving one's Tech-PACK are given.

### Mathematics and Science Content Knowledge

Content change is a constant in both mathematics and science. Science concepts in some fields are changing quickly, as teachers strive to keep current on these changes. But even for mathematical and science concepts (arithmetic or the laws of physics) that do not themselves change, the set of concepts and skills students will be required to learn has grown and changed over time and will continue to do so. Countries who want to remain competitive in a global marketplace know that their success depends on the number of workers who can employ science and technology effectively. An increasing number of jobs that never required mathematical or scientific skills are now dependent on them. A modern farmer may need to use his time more efficiently by keeping his accounts on a spreadsheet. He may need to know how to select and use chemicals for purposes ranging from pesticide to fertilizer. Some states are beginning to require higher-level math and science courses of all students, rather than just those planning to attend college. To help train the workforce of tomorrow, all mathematics and science teachers must keep updated on what these new requirements mean for their own content knowledge.

As mentioned earlier in the chapter, elementary teachers face a special challenge because the number of math and

science skills young students must master is increasing. This means teachers at this level must become content experts in mathematical and science topics they may not have learned in their basic teacher education programs.

### Mathematics and Science Pedagogical Knowledge

Teachers are also challenged to know the most effective ways to have students “do” science and math. They must teach in ways that are engaging and motivational, yet highly effective in raising achievement. Learning by doing requires a constructivist mindset that is new to many teachers, young and old alike, especially if they have not learned that way themselves. Online pedagogy is especially challenging. How does a teacher have students do hands-on/minds-on math and science in a virtual environment? Many of the best teaching practices in these new environments are still being created. One thing that has become clear is that hands-on teaching and assessment methods are more time-consuming than simple lecturing and rote learning. Schools continue to grapple with apparently conflicting goals of providing authentic learning experiences and preparing students to take on-paper tests.

### Mathematics and Science Technological Knowledge

In order to teach students to use the technology tools of mathematics and science, teachers must become masters of these tools. Depending on the topic and grade level they teach, mathematics and science teachers must be expert users of virtual manipulatives, spreadsheets, calculators, graphing calculators, CBL, data loggers, and simulations. They must also be well-acquainted with the growing number of online tools that can help support hands-on lessons. Finally, they must know how to employ distance education tools that can help them keep in touch with their students and updated on their content and pedagogy.

### Strategies for Improving Tech-PACK in Mathematics and Science Instruction

Strategies to improve Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

# TOP TEN

## Strategies for Integrating Technology in Mathematics and Science Instruction

Take advantage of these ten powerful strategies for using technology to enhance the teaching of mathematics and science.

SOURCE	TRACK	SELECTION
<b>Mathematics Strategies</b>		
Graphing calculators give students hands-on practice in solving mathematical problems	<b>1</b>	These handy tools help students do mathematical calculations and visualize algebraic concepts in a manner that enhances understanding and problem-solving skills.
Interactive geometry software such as the <i>Geometer's Sketchpad</i> makes abstract concepts easier to understand	<b>2</b>	These software tools make geometric concepts more concrete, visual, and interactive so that students with limited mathematical background can understand them more readily and students with more advanced knowledge can explore them more deeply.
Spreadsheets help students carry out problem-solving and data-driven methods	<b>3</b>	Spreadsheets do the manual calculations involved in solving higher order problems and support students' "what if" problem solving.
Virtual manipulatives support math concept learning	<b>4</b>	These simulated activities offer more flexibility than activities using actual objects as teachers use them to illustrate concepts.
Computer algebra systems (CAS) support learning higher-level math learning	<b>5</b>	These software packages or devices with software help students carry out complex numeric calculations involved in higher-level math problems.
<b>Science Strategies</b>		
Use an online program for doing authentic scientific inquiry	<b>6</b>	Students can use a web-based program, such as the GLOBE project, FeederWatch, or Journey North, to carry out collaborative investigations.
Use computer-based and online simulations to help students' visual scientific processes	<b>7</b>	Through simulated activities, students are able to make visible macroscopic or microscopic phenomena that they would otherwise be unable to observe.
Calculator-based labs give students hands-on practice with scientific data analysis	<b>8</b>	These tools let students collect and analyze data to support science experiments.
GPS and GIS tools let students make observations and analyze data to support scientific investigations	<b>9</b>	Students use these tools to study the weather, land cover, soil, and hydrology.
Have students participate in robotics contests	<b>10</b>	Activities in making and using robots engage students in problem solving and get them interested in engineering principles and careers.



- » **Do I have the mathematics and/or science content knowledge I need to assist my students in meeting the standards within my classroom?** Because of its concern about the level of mathematics and science expertise in its workers and citizens, the United States and other developed nations have developed many online and in-person opportunities for learning new content in these areas. Most are free to teachers. Consult some of the websites listed in Tables 1 and 2 and the Top Ten feature for this chapter to learn more about these opportunities.
- » **Do I have the technological knowledge needed to teach the mathematics and/or science content within my classroom?** To implement technology-enabled teaching strategies, teachers will have to learn a number of technologies that may be new to them. They will hear about these resources from their professional magazines and journals and from other teachers they encounter in person and online. But the expertise they need to use these tools themselves must come from hands-on professional development provided by their districts and by state and local professional organizations. They will have to search for workshops and

conferences that focus on these tools and take advantage of the expertise of teachers they know who have already begun using these tools.

- » **Do I have the pedagogical knowledge needed to teach the mathematics and/or science content within my classroom?** The same websites that offer content updates and learning opportunities also provide lesson plans that model how to integrate technologies most effectively into classroom studies. Some of these sites also have videos of educators talking about their best practices with digital tools.

At the end of this chapter, you will deconstruct a teacher's Tech-PACK based on what you know of their knowledge and what must be learned to teach science and mathematics effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone in your own content area.



## SUMMARY

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

**1. Issues and Problems in Mathematics Instruction**—Each current issue has implications for how teachers can and should integrate technologies, including accountability for standards in mathematics, challenges in implementing the principles and standards for school mathematics, and directed vs. constructivist teaching strategies: ongoing “math wars.”

**2. Technology Integration Strategies for Mathematics Instruction**—Integration strategies offer support for: Bridging the gap between abstract and concrete with virtual manipulatives, allowing representation of mathematical principles, supporting mathematical problem solving, implementing data-driven curricula, supporting math-related communications, and motivating skill building and practice.

**3. Issues and Problems in Science Instruction**—Each of these current issues has implications for how teachers can and should integrate technologies, including accountability

for standards in science, the narrowing pipeline of scientific talent, increasing need for scientific literacy, difficulties in teaching K–8 science, and objections to virtual science labs.

**4. Technology Integration Strategies for Science Instruction**—Integration strategies offer support for: Involving students in scientific inquiry through authentic online projects, support for specific processes in scientific inquiry, supporting science skills and concept learning, engaging students in engineering topics through robotics, and accessing science information and tools.

**5. Tech-PACK Needs and Challenges in Mathematics and Science Instruction**—To integrate technologies effectively, teachers must have a combination of science and mathematics content knowledge, pedagogical knowledge, and technological knowledge. Strategies for improving your Tech-PACK in these areas are given.



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** As noted in this chapter, the “math wars” continue between those who believe math should be explicit and teacher-directed and those who advocate a more constructivist approach. How do technology integration strategies differ between these two positions? Are there ways to combine them?

**2.** As noted in this chapter, the National Science Teachers Association (NSTA) and the American Chemical Society (ACS) have taken the position that “hands-on” means that students must touch the materials rather than “do” science on a computer. Both organizations have issued position statements arguing against using computer simulations as a substitute for in-person,

in-school laboratory experiences. Can you cite evidence that some science skills cannot be learned from a virtual lab experience? If so, what are they?

**3.** In the U.S. government’s 2010 report, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*, the authors make the case that the country is not making the necessary investments in science and technology to remain globally competitive. Go to the National Academies Press website (<http://www.nap.edu>) and download and read a free copy of the report. What role does educational technology play in their recommendations?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Mr. Curry has been teaching algebra in a very traditional way for over 25 years. Everyone considers him a master of mathematical content, and his colleagues often consult him about math problems. In his classes, his usual teaching method is to talk briefly about a new topic, illustrate to students how to work the problems, assign other problems for classwork while he assists them, and, finally, assign more problems for homework. He has his students use calculators in later parts of the course, but he has never used computers or any other technologies in his teaching. His new principal is an advocate of using constructivist, student-centered methods and has asked Mr. Curry to work with Ms. Fresh, the new science teacher, on a joint math-science project using CBLs. Mr. Curry is intrigued by the technology and is willing to try something new. However, he doesn't know where to begin learning about what he should do.*

- a. Deconstruct Mr. Curry’s Tech-PACK in the following way. Fill in the following matrix to show what he knows and what he will have to learn in terms of content, technologies, and pedagogies in order to be in his Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that he must address to implement this new strategy effectively in his classroom.

you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement this new strategy effectively in your classroom.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic



**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.



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# TEACHING AND LEARNING WITH TECHNOLOGY IN SOCIAL STUDIES INSTRUCTION

# TEACHING AND LEARNING WITH TECHNOLOGY IN SOCIAL STUDIES INSTRUCTION

[A]s the primary purpose of social studies is to prepare the young people of today to be the citizens of tomorrow, it is necessary to examine how technology tools impact, improve, and otherwise affect teaching and learning in social studies.

John Lee and Adam Friedman,  
*Research on Technology in Social Studies Education* (2009)

## o u t c o m e s

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

1. Recognize the implications for technology integration of each current issue faced by social studies teachers.
2. Create key strategies for integrating technology into social studies curricula.
3. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to social studies teachers.



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## key terms

adventure learning (AL)  
digital storytelling  
geocaching  
geospatial technologies

Global Positioning System (GPS)  
information visualization  
social studies  
virtual field trips



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## TECHNOLOGY INTEGRATION IN ACTION: LEARNING GEOGRAPHY WITH GEOSPATIAL TECHNOLOGIES

GRADE LEVEL: 4–12 • CONTENT AREA/TOPIC: History, geography, civics, economics • LENGTH OF TIME: One week

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

Ms. Clausen just graduated with a degree in social studies education and was excited to be preparing for her first year of teaching in a high school. Although her degree was in social studies education, she focused primarily on history and the majority of her coursework was in that area. Thus, when she learned that she was going to be teaching an introduction to geography course she was quite nervous, as she had only taken one course in that area in her entire undergraduate program.

As Ms. Clausen read through the state standards in social studies, she realized that several standards included the use of geographic information systems (GIS) at the secondary level. These standards were:

- » Students should know and understand what GIS is and how it is used in everyday life.

- » Students should know and understand how a geographer uses GIS to solve everyday problems.
- » Students should know and understand the various GIS technologies and the affordances of each of the technologies (desktop, server, mobile, and online).
- » Students should use a GIS to problem-solve solutions to societal issues as a geographer in a minimum of two scenarios.

She began looking for resources that would help her address these standards while making learning geography meaningful and engaging for her students. She wanted to make sure that students perceived learning about geography and GIS as relevant and useful to them.

The summer before she was to begin teaching, she attended a local social studies conference and participated in a workshop about a new online geography learning environment called *GeoThentic*. She learned that it was an all-inclusive environment that provided many hands-on activities and strategies for learning GIS and related geography tools. The workshop presenters presented research results on how *GeoThentic* motivates students. She felt that this environment provided the support she would need both to address the state standards with good



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teaching strategies and to make the learning of geography more hands-on and exciting for her students.

### Step 2: Assess Tech-PACK.

Ms. Clausen knew that before she could integrate the technologies in *GeoThentic* into her geography course, she would need several kinds of preparation.

**Content Domain.** First, she would need to review all the state standards and geography content thoroughly, since she had only one formal course in that area. She found a book from the Environmental Systems Research Institute (ESRI) Press called *Mapping Our World: GIS Lessons for Educators* and went to the ESRI website (<http://www.esri.com>), where she learned a great deal about online mapping.

**Pedagogy Domains.** She also found that *GeoThentic* offered online professional development opportunities to help her become more confident with both her content knowledge and tools such as GIS, as well as strategies for teaching geography.

**Technology Domain.** She spent a great deal of time immersing herself in *GeoThentic's* materials and became proficient in the use of GIS and other tools such as *Google Earth*. She realized that her knowledge in this area would be something she would develop over time, but after several weeks of preparation, she felt ready to begin creating lesson plans.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Ms. Clausen decided on three *GeoThentic* modules that would allow her students to meet the standards. She decided she would begin with the module on San Francisco that focused

on analyzing data such as earthquake shaking amplification, population density, fault lines, and traffic patterns. She would have them analyze these data in order to identify a location for a new hospital in the city that would best minimize threats from earthquakes. Students would have numerous layers of data to make the most informed decision, exactly in the same way a geographer or urban planner would in society today. Each student would provide a justification for the choice based on their data analysis. She created the following outcomes, objectives, and assessments to measure students' achievement:

- » **Outcome:** Know the various GIS technologies and the affordances of each of the technologies. **Objective:** Demonstrate the use of GIS on the computer and online. **Assessment:** Individually, students will identify the advantages and disadvantages of using geospatial tools such as *Google Earth* and *ArcGIS*. Using the same sets of data, students will create maps that showcase their understanding of the population density within their state while comparing the differences between *Google Earth* and *ArcGIS*. The assessments will be graded for understanding using a rubric highlighting that each student developed a complete map that includes the necessities of a title, orientation, date, author, legend, and scale (TODALS) along with a personal evaluation of each geospatial tool.
- » **Outcome:** Know what GIS is and how it is used in everyday life. **Objective:** Use GIS to identify the geologic and geographic factors that make earthquakes likely in San Francisco. **Assessment:** Using the San Francisco data sets, students will identify the highest risk areas for earthquakes within the San Francisco region. The assessments will be graded for understanding using a rubric that identifies that each student analyzed various data sets taking into account the possible areas of earthquake risk.
- » **Outcome:** Know how a geographer uses GIS to solve every day problems. **Objective:** Use GIS to analyze various locations and select the best site for a hospital. **Assessment:** Working in small groups, students will create and give a *PowerPoint* presentation that communicates their selected site for a hospital in San Francisco, along with a detailed justification that includes the data analysis. The assessments will be graded for understanding using a rubric that denotes the quality of the slides along with the presentation to the class.

### Step 4: Design integration strategies.

Ms. Clausen wanted the project to be one where the students had the freedom to explore the tools available to them and create their own strategies for using them. However, she wanted to

make sure that students had mastered use of the tools first. With this in mind, she created the following activity sequence:

- » **Days 1-2:** In the computer lab, use the video on the *GeoThentic* website to introduce the San Francisco module. Then introduce the *GeoThentic* environment and *Google Earth* materials. Allow students the opportunity to learn about the technology resources and GeoPacks available to them in *GeoThentic*.
- » **Days 3-6:** Have students work in groups to do the five tasks to learn about San Francisco, earthquakes, and the steps to GIS analysis. Students perform GIS analysis using the data sets within *Google Earth*. They analyze the best location to build a hospital looking at data sets such as liquefaction, earthquake fault lines, population density, and major roads. Students submit their location and justification as a GeoPack.
- » **Day 7:** Students present their selected sites and justifications. Students do written critiques of each group's analysis.

### Step 5: Prepare instructional environments.

Finally, Ms. Clausen knew she needed to identify if the essential conditions were in place to support the use of *GeoThentic* within her classroom. Therefore, her preparation included the following:

- » **Materials:** The materials for this lesson included the *GeoThentic* environment and *Google Earth*, both free resources. However, Ms. Clausen had to figure out if *Google Earth* was installed on the computers within the computer lab. Also, when she had tried using *GeoThentic* earlier on her personal computer it wouldn't run as it needed *Flash* to be installed. Thus, Ms. Clausen called the technology coordinator and set up a meeting to see if these two issues could be resolved. After the meeting she was assured that all computers in the lab would have *Flash* installed and that a test run would ensue to make sure *Google Earth* loaded properly.
- » **Computer Scheduling:** Ms. Clausen needed to make sure she got on the lab schedule so she could use the computers when she wanted. She was happy it wasn't state standard testing time because the labs were always filled with students practicing for standardized tests. Fortunately, Ms. Clausen reserved the computer lab for the required time. She wanted to make sure she had an extra day just in case she or the students needed more time.

A week later Ms. Clausen jumped into teaching the first module on San Francisco. She followed the module as it was written. She introduced the basics of *GeoThentic* and *Google Earth* followed by a look at the region of San Francisco and earthquakes

followed by the relationships between the two. She then looked at some classic earthquake experiences over the past century, ranging from the 1906 San Francisco "Great Quake" to the more recent Haiti earthquake. She then introduced what GIS is, how geographers around the world use it, and how analyses of everyday activities can be accomplished with the technology. Her students then jumped into performing the analyses and reporting out their solutions.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

Ms. Clausen followed the online lesson exactly as it was written, and for the most part, it went very well. She spent a great deal of time reflecting on her pedagogical strategies, her students' performances, and informal and formal feedback from her students. In fact, Ms. Clausen administered the following self-assessment to review how it worked for her:

- » Did students' products reflect growth in their thinking about the role of geography in society?
- » Did the students become engaged in each of the tasks?
- » Did each of the software and web resources work as smoothly as expected?
- » Did the students perform well within the online environment?

### Step 7: Make revisions.

She identified that the main issue that impacted performance was time. She felt she hadn't provided enough time to allow students to investigate the many resources that were provided within *GeoThentic*. She felt that this content was necessary for her students to have a thorough understanding of the big picture of geography and GIS analysis. She also realized that if she spent the first third of each class showcasing the procedural knowledge of using a GIS to her students that they performed much better when it came to the analysis. Overall, Ms. Clausen was very excited about her students' performances and her ability to teach content with a technology that she was not very comfortable with initially. Before moving into the next module, Ms. Clausen made the necessary revisions to her lessons. She curtailed the daily lessons to allow for more time within the computer lab while also providing more time for students to do the actual GIS analysis and less time on the delivery of content.

**Source:** Based on *GeoThentic* Learning Environment, <http://lt.umn.edu/geothentic>.

## ISSUES AND PROBLEMS IN SOCIAL STUDIES INSTRUCTION

Since the Industrial Revolution, science and technology have shaped the world in fundamental ways. In the 1990s, computer technologies and the emergence of the Internet have accelerated this influence. Better, faster, worldwide communications have made the world at once smaller and more complex. Life was simpler—and less informed—when people were not able to know so much about themselves and others so quickly. Now, with so much information readily available, we have much to discover about our world and its people. But it is through this exploration that we make our world more like the place we want it to be—be it for better or for worse. Just 30 years ago, the Internet, cell phones, DVDs, computers, and public transportation as we know it today did not exist. Technology is quickly changing our life and our life is changing the environment just as quickly.

The National Council for the Social Studies (NCSS) has adopted the following formal definition for the **social studies**:

Social studies is the integrated study of the social sciences and humanities to promote civic competence. Within the school program, social studies provides coordinated, systemic study drawing upon such disciplines as anthropology, archaeology, economics, geography, history, law, philosophy, political science, psychology, religion, and sociology, as well as appropriate content from the humanities, mathematics, and the natural sciences. The primary purpose of social studies is to help young people develop the ability to make informed and reasoned decisions for the public good as citizens of a culturally diverse, democratic society in an interdependent world (National Council for the Social Studies, 2010, p. 3; reprinted by permission).

As an area that focuses on the interconnections of people and the earth, social studies education has been affected by the impact of technology perhaps more than any other content area. Not only is there more to learn about the world than ever before, but also the information is changing constantly and dramatically. Fortunately, the same technologies that created this more complex world also can help teach about it. Unfortunately, Martorella's (1997) comment that technology within the social studies is a "sleeping giant" has not yet been realized. Bolick (2004), however, argues that the "giant is waking" in certain areas within the social studies and calls for collaboration between social studies teacher educators, instructional designers, and technology specialists to realize the potential of technology within social studies education. Doering, Veletsianos, and

Scharber (2007) believe that the "vision of a fully awake and functioning 'giant' can be a reality through taking to heart and understanding the lessons learned about technology integration from the field of learning technologies and from using theoretical frameworks focused on pedagogy as guides for future social studies educational research" (p. 214).

Various issues shape the technologies social studies teachers choose and the uses they make of them. This section reviews these issues, which include: required social studies standards, challenges in teaching social studies, debates about how best to teach social studies content, and the impact of the "information explosion" on social studies content and methods.

### Required Social Studies Instruction Standards

The National Social Studies Standards, released in 2004 and revised in 2010, address overall curriculum design and comprehensive student performance expectations. However, standards also exist for each of the social studies disciplines—such as civics, economics, geography, government, and history—which provide more specific content detail for each discipline. The social studies teacher often needs to be a "jack of all trades" and hopefully a master of more than one content area. Unfortunately, many pre-service teachers who are social studies majors get tracked into areas, such as history, where it is felt they most likely can get a job, leaving courses in content areas such as economics and geography last on their list.

The intent of the NCSS standards is to encourage curriculum designers to use the NCSS social studies standards for creating the overall framework and then fill in the detail using the discipline standards. Ten themes form the framework of the social studies standards; those, along with a brief description of each, are presented next (NCSS, 2010). At the elementary and middle school levels, school systems usually address the social studies curriculum by teaching a variety of topics from these strands. In high school, social studies tends to become divided into more specific areas, such as history and civics. Thus, when referring to a course, the term social studies is more commonly used to describe K–8 classes than high school classes.

- » **Theme 1: Culture**—The study of culture prepares students to answer questions such as: What are the common characteristics of different cultures? How do belief systems, such as religion or political ideals, influence other parts of the culture? This theme typically appears in units and courses dealing with geography, history, sociology, and anthropology, as well as multicultural topics across the curriculum.

- » **Theme 2: Time, continuity, and change**—Humans seek to understand their historical roots and to locate themselves in time. Knowing how to read and reconstruct the past allows one to develop a historical perspective and to answer questions such as: Who am I? What happened in the past? How am I connected to those in the past? How has the world changed, and how might it change in the future? Why does our personal sense of relatedness to the past change? This theme typically appears in courses in history and others that draw on historical knowledge and habits.
- » **Theme 3: People, places, and environments**—The study of people, places, and human–environment interactions assists students as they create their spatial views and geographic perspectives of the world beyond their personal locations. Students need the knowledge, skills, and understanding to answer questions such as: Where are things located? Why are they located where they are? What do we mean by “region”? How do landforms change? What implications do these changes have for people? This theme typically appears in units and courses dealing with area studies and geography.
- » **Theme 4: Individual development and identity**—Personal identity is shaped by culture, groups, and institutional influences. Students should consider such questions as: How do people learn? Why do people behave as they do? What influences how people learn, perceive, and grow? How do people meet their basic needs in a variety of contexts? How do individuals develop from youth to adulthood? This theme typically appears in units and courses dealing with psychology and anthropology.
- » **Theme 5: Individuals, groups, and institutions**—Institutions such as schools, houses of worship, families, government agencies, and the courts play an integral role in our lives. It is important that students learn how institutions are formed, what controls and influences them, how they influence individuals and culture, and how they are maintained or changed. Students may address questions such as: What is the role of institutions in this or other societies? How am I influenced by institutions? How do institutions change? What is my role in institutional change? This theme typically appears in units and courses dealing with sociology, anthropology, psychology, political science, and history.
- » **Theme 6: Power, authority, and governance**—Understanding the historical development of power, authority, and governance and their evolving functions in contemporary U.S. society and other parts of the world is essential for developing civic competence. In exploring this theme, students confront questions such as: What is power? What forms does it take? Who holds it? How is it gained, used, and justified? What is legitimate authority? How are governments created, structured, maintained, and changed? How can individual rights be protected within the context of majority rule? This theme typically appears in units and courses dealing with government, politics, political science, history, and law.
- » **Theme 7: Production, distribution, and consumption**—Because people have wants that often exceed available resources, a variety of ways have evolved to answer these questions: What is to be produced? How is production organized? How are goods and services distributed? What is the most effective allocation of factors of production such as land, labor, capital, and management? This theme typically appears in units and courses dealing with economic concepts and issues.
- » **Theme 8: Science, technology, and society**—Modern life would be impossible without technology and the science that supports it. But technology raises many questions: Is new technology always better than old? What can we learn from the past about how new technologies result in broader social change, some of which is unanticipated? How can we cope with the ever-increasing pace of change? How can we preserve our fundamental values and beliefs in the midst of technological change? This theme draws on the natural and physical sciences, social studies, and the humanities, and appears in a variety of social studies courses, including history, geography, economics, civics, and government.
- » **Theme 9: Global connections**—The realities of global interdependence require an understanding of the increasingly important and diverse global connections among world societies and the frequent tension between national interests and global priorities. Students need to be able to address such international issues as health care, the environment, human rights, economic competition and interdependence, age-old ethnic hostilities, and political and military alliances. This theme typically appears in units or courses dealing with geography, culture, and economics, but it may also draw on the natural and physical sciences and the humanities.
- » **Theme 10: Civic ideals and practices**—An understanding of civic ideals and practices of citizenship is critical to full participation in society and is a central purpose of the social studies. Students confront questions such as: What is civic participation, and how can we be involved? How has the meaning of citizenship evolved? What is the balance between rights and responsibilities? What is the role of the citizen in the community and the nation and as a member of the world community? This theme typically appears in units or courses dealing with history, political science, and cultural anthropology, and fields such as global studies, law-related education, and the humanities.



## Challenges When Teaching Social Studies

Despite their obvious value and relevance to future citizens, social studies themes and topics are not usually among those included in statewide assessments. Many states limit their graduation tests to language arts (i.e., reading and writing) and mathematics. Since many teachers tend to focus instruction primarily on tested topics, social studies areas are often placed on the back burner and are also taught inconsistently across grade levels (Mathis & Boyd, 2009). Consequently, school resources such as technology materials tend to be directed toward other content areas.

The sheer amount of material to review in many social studies topic areas is also a concern. A good example is a world history course, which often covers the period from the dawn of civilization to the present day. The amount of content, coupled with the de-emphasis on social studies topics, creates an ongoing challenge to schools to teach social studies in a meaningful way. A longstanding joke within social studies circles goes like this: “Did you get past World War I this year?”—referring to the large amount of content to be covered and the short amount of time in a school year to do so. Unfortunately, in many cases, this old joke reflects the reality of the challenge social studies teachers face.

Adding to this challenge is the changing role of technology itself. At first, teachers looked at technology resources as a collection of tools to help teach specific content and skills. However, as teachers began to see technology making profound changes in social, civic, and economic functioning, they saw value in more constructivist uses (Doering & Veletsianos, 2007; Hammond & Manfra, 2009; Wilson & Wright, 2010).

Finally, there is the issue of costs for high-quality resources. For example, it costs over \$1,000 to equip 30

computers with *TimeLiner* software, a piece of software that allows students to organize data on multimedia timelines. Social studies teachers have to make the case that the expense of these resources is worthwhile due to increased achievement or other benefits while also understanding how to use constructivist technologies effectively. Fortunately, a number of free technologies have become available, such as Google Earth, ESRI’s ArcGIS, and Google Documents. There are also more and more free software options (see Open-Source Options feature).

## The “History Wars” and Other Debates on the Content and Focus of Social Studies

Social studies has attracted more debate and criticism than perhaps any other content area, and much of this discussion centers around the appropriate role of history in the curriculum. In recent years, leaders in the field of social studies have made the case that students should be aware of the broad array of influences that have shaped our country’s history. Critics of this approach feel that the content of history courses has become diluted—that courses focus too much on topics they consider to be outside the mainstream, traditional historical themes and important events that shaped the United States. These critics feel that teachers who are not well prepared in the latter approach are ill-equipped to teach history effectively. As a result, the disciplines within the social studies each have their own camps that are fighting for more coverage within the schools and financial support to prepare teachers effectively. For example, the National Geographic Society and their alliance network throughout the United States have been lobbying Congress to pass the

## Free open source **OPTIONS** for Social Studies Teaching

### INSTRUCTIONAL OPTIONS

### FREE SOURCES

#### Geospatial technologies

Open Source GIS: [http://www.ppgis.net/opensource\\_gis.htm](http://www.ppgis.net/opensource_gis.htm)  
Map Window: <http://www.mapwindow.org>

#### Video development

Avidemux: <http://www.osalt.com/avidemux>  
Kino: <http://www.osalt.com/kino>

#### Concept mapping

FreeMind: [http://freemind.sourceforge.net/wiki/index.php/Main\\_Page](http://freemind.sourceforge.net/wiki/index.php/Main_Page)  
VUE: <http://vue.tufts.edu>

“Teaching Geography is Fundamental Act”—a bill to improve and expand geographic literacy among kindergarten through grade 12 students in the United States by improving professional development programs for kindergarten through grade 12 teachers offered through institutions of higher education. Although it was first introduced in 2005, as of the spring of 2011, it still has not been passed.

## Perils of the Information Explosion

The ready availability of information on the Internet has created several concerns for social studies educators. Some believe that Internet information has the potential to alter the traditional relationship between student and teacher since teachers are no longer the primary source of facts or opinions. Teachers tell of students bringing printed web pages to school that contradict what the textbook says or even what the teacher says. In the past, most information that

students received was sifted through a reliable filter; today, those filters often are nonexistent. Students can find sites that profess Nazi and Ku Klux Klan ideology, treat rumor as fact, and promote conspiracy theories that range from UFO landings in Roswell, New Mexico, to the CIA selling drugs in American cities. Many students have been drawn to these types of sites without questioning their accuracy.

Many educators believe we need information literacy or media literacy now more than ever. Some believe that rather than shying away from the hate or conspiracy sites, we should be using them as demonstration tools to teach our students how to become critical consumers of information. The information explosion has virtually and literally opened the world to social studies educators and their students. From the most recent data that are readily available for analysis to virtual field trips to constructivist opportunities for students to create their own stories, the Internet is providing numerous exciting teaching and learning opportunities. One of the many exciting opportunities is the access to mobile apps that can be used to teach the social studies (see Mobile Apps for Education).



Many educators believe we should use controversial websites as demonstration tools to teach our students how to become critical consumers of information.  
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## TECHNOLOGY INTEGRATION STRATEGIES FOR SOCIAL STUDIES

Technology tools make possible a variety of strategies to enhance learning for the varied topics and concepts that comprise social studies content. The strategies described here support both traditional, directed approaches to teaching social studies topics as well as constructivist uses of technology. Depending on the teachers’ goals, they need to identify and use the appropriate technology to support the teaching of the content. The following integration strategies suggest activities to address each of the 10 themes in the NCSS National Social Studies Standards.



# MOBILE APPS FOR EDUCATION

## SOCIAL STUDIES

App Name	Description	Device
<b>World Book</b> 	This Day in History is an interactive multimedia calendar that displays historical events for the current day or any selected day, along with related media such as photos, illustrations, music, and speeches. Students can hear the national anthems of countries on the day they became a nation, listen to presidents’ speeches on the anniversaries of their inaugurations, and play sound clips from famous artists on their birthdays.	iPad

Source: This Day In History icon © 2011 The Software MacKiev Company. Reprinted by permission.

## Simulated Problem-Solving Environments

Many social studies topics present issues, concepts, or procedures that at first are complex and confusing to students. Simulations, or electronic environments that allow students to interact with simulated events or locations, can help make these concepts more clear and meaningful. It is for this reason that simulations have been a popular resource in social studies learning since the early days of microcomputers in schools. Some simulations allow students to take an active part in historical situations that would not otherwise be possible due to historical or physical distance. Other problem-solving environments situate learning in authentic situations using real-world data and situated movies to motivate students (Doering & Veletsianos, 2007). These products are designed to immerse students in problem-solving scenarios where they must make decisions and apply information they have learned.

Updated versions of some of the early simulations (e.g., *The Oregon Trail*) are still being used, and other, more sophisticated simulations have emerged as technology has become more capable (e.g., *GeoThentic*, Muzzy Lane's *Making History*). By placing students in the role of decision makers in these simulations, they not only see the relevance of social studies in their daily lives, but they also develop better problem-solving skills. Some popular examples of simulated problem-solving environments that address various social studies themes are listed in Table 1.

## Information Visualization

Students often have problems visualizing abstract concepts and data. The availability of large data sets combined with exponential growth in hardware and software capability creates the potential

to improve communication through the use of enhanced visualization techniques (Liu, Nersessian & Stasko, 2008; Miller, Hooper & Lecheler, 2009; Sorapure, 2010). **Information visualization** is commonly referred to as information design, and “uses pictures, symbols, colors, and words to communicate ideas, illustrate information, or express relationships visually” (Emerson, 2008, p. 4). In the past, teachers strove to use various technologies to represent concepts and data graphically, which can help novices understand and apply them. Today, even students can use products such as graphing software, spreadsheets, and numerous online information visualization sites to put data into a concrete form for easier analysis and representation of concepts, allowing concepts to be depicted visually. Information visualization products (see Table 2) allow students to understand time sequences, track change over time, and represent complex data in ways that can be readily understood.



Students working on analyzing data using geospatial technologies is becoming a common practice in the social studies classroom.  
Photo by Learning Technologies Media Lab, University of Minnesota..

**TABLE 1 Simulated Problem-Solving Resources for Social Studies Education**

Sample Learning Sites	Social Studies Themes
Muzzy Lane's <i>Making History</i> <a href="http://www.muzzylane.com">http://www.muzzylane.com</a>	Theme 2: Time, continuity, and change Theme 6: Power, authority, and governance
<i>The Oregon Trail</i> <a href="http://www.learningcompany.com">http://www.learningcompany.com</a>	Theme 2: Time, continuity, and change Theme 7: Production, distribution, and consumption
<i>GeoThentic</i> <a href="http://www.geothentic.umn.edu">http://www.geothentic.umn.edu</a> <i>iEARN Collaboration Center</i> <a href="http://media.iearn.org">http://media.iearn.org</a>	Theme 1: Culture Theme 3: People, places, and environments Theme 9: Global connections
The International Communication and Negotiation Simulations (ICONS) <a href="http://www.icons.umd.edu">http://www.icons.umd.edu</a>	Theme 9: Global connections
<i>Who Killed William Robinson?</i> <a href="http://www.canadianmysteries.ca/sites/robinson/home/indexen.html">http://www.canadianmysteries.ca/sites/robinson/home/indexen.html</a>	Theme 1: Culture Theme 4: Individual development and identity

## Virtual Field Trips

Field trips have been used as a context for teaching and learning in the social studies ever since the Internet entered the K–12 classroom (Noel, 2007). Stoddard (2009) noted that “virtual field trips can provide students the opportunity to construct knowledge actively through interacting with historic places, experts, and artifacts. When integrated into the curriculum and not used as rewards, field trips can be among the most valuable and effective modes of history teaching, especially local historic sites” (p. 1). **Virtual field trips** are “visits” students make to Internet sites to see places they could not easily go to in real life or that can help them get more out of trips they are able to take. For example, visiting foreign locations gives students a richer, more comprehensive perspective on the world around them and makes the world a living part of their classroom (see Table 3). For students who may travel little, the wealth of images and information from virtual field trips helps them see and understand the variety of cultures, sights, and events outside their own communities. Virtual field trips also offer budget-friendly opportunities for schools and students who are not able to afford the expenses of physical field trips, while at the same

time reaching an unlimited number of students. Noel (2007) identified three main elements of a “winning” field trip:

- » Field trips need to have a connection to the curriculum and should be timed to line up logically with curriculum.
- » Teachers need to work with field trip site personnel to enhance student learning.
- » Teachers need to prepare students in class before the trip, especially through the use of materials from the field trip site, such as relevant primary documents or artifacts.

## Adventure Learning

**Adventure learning (AL)** is a hybrid distance education approach that provides students with opportunities to explore real-world issues through authentic learning experiences within collaborative learning environments (Doering, 2006; Doering, 2007; Doering & Veletsianos, 2007; Miller, Hokanson, Doering & Brant, 2010; Veletsianos & Doering, 2010). AL is much different than a virtual field trip in that this hybrid approach includes a K–12 curriculum designed

**TABLE 2** Information Visualization Resources for Social Studies Education

Sample Learning Sites	Social Studies Themes
Neighborhood MapMachine <a href="http://www.tomsnyder.com">http://www.tomsnyder.com</a>	Theme 3: People, places, and environments
TimeLiner XE <a href="http://www.tomsnyder.com">http://www.tomsnyder.com</a>	Theme 2: Time, continuity, and change Theme 7: Production, distribution, and consumption
Graph Club <a href="http://www.tomsnyder.com">http://www.tomsnyder.com</a>	All themes
Simple Complexity <a href="http://simplecomplexity.net">http://simplecomplexity.net</a>	All themes

**TABLE 3** Virtual Field Trip Resources for Social Studies Education

Sample Learning Sites	Social Studies Themes
Louvre Museum <a href="http://www.louvre.fr">http://www.louvre.fr</a>	Theme 1: Culture Theme 2: Time, continuity, and change Theme 3: People, places, and environments
This Land <a href="http://interactive.nfb.ca/#/thisland">http://interactive.nfb.ca/#/thisland</a>	Theme 1: Culture Theme 2: Time, continuity, and change Theme 3: People, places, and environments Theme 9: Global connections
Colonial Williamsburg’s Electronic Field Trip <a href="http://www.history.org/history/teaching/pscufs">http://www.history.org/history/teaching/pscufs</a>	All themes

with activities that work in conjunction with an authentic activity. For example, in the *Earthducation* Adventure Learning Series and the *GoNorth!* Adventure Learning Series, explorers and educators travel throughout the world as students experience the travels with them virtually. The all-inclusive curriculum, the travel experiences and observations of the teams and the online learning environment are delivered concomitantly so that students are able to make connections among what is happening in the real world, their studies, and the collaboration and interaction within the online learning environment. As students collaborate to study a topic or to create a product, these projects promote communication, encourage reflection, and provide a wealth of information to support students' research (see Figure 1).

Numerous studies (Doering, Scharber, Riedel, & Miller, 2010; Veletsianos & Doering, 2010) have noted the student learning and motivational qualities of using AL within the K–12 classroom. Students feel as if they are part of the narrative that is unfolding within an AL project, and thus, their motivation to be part of the project and collaborate with other learners is extremely high. The sites listed in Table 4 are good sources for adventure learning projects.

## Digital Storytelling

Digital literacies has numerous descriptors, but ultimately we know that students should become digitally literate (O'Brien & Scharber, 2008). One way students can showcase their digital literacy is through **digital storytelling**. Digital storytelling is the process of using images and audio to tell the stories of lives, events, or eras. In this technique, students use personal narrative to explore community-based history, politics, economics, and geography. These projects offer students the opportunity to make their own lives a part of their scholarly research. Ferster, Hammond, and Bull (2006) noted that a larger percentage of students will voluntarily engage in creating digital storytelling than are willing to write a traditional essay. In fact, students returned to school on their own time

## FIGURE 1 *Earthducation* Adventure Learning Series



Source: Courtesy of *Earthducation* Adventure Learning Series, Learning Technologies Media Lab, University of Minnesota, <http://it.umn.edu>.

to finish their digital projects. The use of digital images in the social studies can accomplish many purposes:

1. Assist students in comparing and contrasting the past and the present
2. Sensitize students to diverse perspectives and biases
3. Provide visual cues that reinforce geographic concepts
4. Represent abstract and concrete social studies concepts (e.g., democracy, liberty, needs and wants)
5. Foster skills in analysis and critical thinking
6. Facilitate greater connections to the community
7. Personalize associations with the study of geography, history, economics, government, and other related disciplines.

**TABLE 4** Adventure Learning Resources for Social Studies Education

Sample Learning Sites	Social Studies Themes
<i>GoNorth!</i> Adventure Learning Series <a href="http://www.polarhusky.com">http://www.polarhusky.com</a>	All themes
The JASON Project <a href="http://www.jason.org">http://www.jason.org</a>	Theme 1: Culture Theme 2: Time, continuity, and change Theme 3: People, places, and environments Theme 9: Global connections
<i>Earthducation</i> Adventure Learning Series <a href="http://www.earthducation.com">http://www.earthducation.com</a>	All themes

With the exploding world of Web 2.0 technologies, many digital tools can be used to create digital stories. Using technologies such as Apple's *iMovie*, camcorders, digital cameras, and voice recorders, student can create amazing stories. In fact, students can now create digital stories alone on their mobile phones, such as on Apple's iPhone. By sending students into their world with a digital camera in hand, teachers provide opportunities for them to bring their lives into the classroom, creating a rich, authentic authoring space. Writing text and arranging pictures as artifacts within a digital space allows students to explore events from multiple perspectives. As an extension or adaptation, students might create digital movies about an event, place, or individual, using the camera to capture scenes and artifacts that could be woven together to tell a particular story. After creating the digital story, the student posted it onto the class website that was created for the class for her colleagues to watch. Table 5 lists websites that support digital storytelling. There are many options to adapt learning for special needs in the social studies, as shown in the Adapting for Special Needs feature.

## Digital Information Critiques

History is replete with examples of the use of manipulated images to control people's impressions and opinions. As citizens in the Digital Age, students need to develop skills in critically evaluating digital information—how to analyze images and tell fact from fiction. Social studies activities provide a context for simultaneously exploring the social impact of images and developing media literacy skills. (See Table 6. See also the Hot Topic Debate on this area.)

## Electronic Research

As students study areas such as politics, economics, and current events, information is likely to change quickly and frequently. Internet sources give students and teachers up-to-date information they could not obtain easily from other sources. Also, access to information summaries and examples of data “pictures” on the Internet help students learn to analyze information in both graphic and text forms. Since we are relying more and more on Internet sources for reliable, up-to-date information, students must learn where they can look for various kinds of data and facts they need to complete research in school and, later, at work. Technology Integration Example 1 provides an example of this strategy, and Table 7 lists sample products that support electronic research.

## Geospatial Analysis

**Geospatial technologies**, the use of technology for visualization, analysis, and measurement of features and phenomena, are becoming some of the most popular technologies in the K–12 classroom. In fact, the uses of these technologies are being written in social studies standards throughout the nation and thus, teacher education programs are taking note. The use of geospatial technologies, such as *Google Earth* and *ArcGIS*, allow individuals to view and examine the world through multiple layering of data sets (population density, roads, earthquake activity) within a spatial environment (see Figure 2). Although access to and use of such technology was previously limited by steep costs and demanding hardware, recently geospatial technologies have become increasingly

**TABLE 5** Digital Storytelling Resources for Social Studies Education

Sample Sites	Social Studies Themes
Voice Thread <a href="http://www.voicethread.com">http://www.voicethread.com</a>	All themes
Center for Digital Storytelling <a href="http://www.storycenter.org">http://www.storycenter.org</a>	All themes
Digital Documentaries <a href="http://www.digitales.us/resources/documentary.php">http://www.digitales.us/resources/documentary.php</a>	All themes
PBS Civil War <a href="http://www.pbs.org/civilwar">http://www.pbs.org/civilwar</a>	Theme 2: Time, continuity, and change
National Archives and Records Administration <a href="http://www.archives.gov">http://www.archives.gov</a>	Theme 2: Time, continuity, and change
Digital Resource Centers (DRC) <a href="http://www.teacherlink.org/content/social/digresources">http://www.teacherlink.org/content/social/digresources</a>	Theme 2: Time, continuity, and change Theme 3: People, places, and environments
The Oral History Society Home Page <a href="http://www.ohs.org.uk">http://www.ohs.org.uk</a>	Theme 2: Time, continuity, and change Theme 3: People, places, and environments



# ADAPTING FOR SPECIAL NEEDS

## Social Studies

**S**ocial studies topics can be challenging for some students with disabilities because of the significant amount of grade level reading required. As a result, educators should consider how to provide multiple means of accessing information such as photos, movies, audio, and simplified text. A strategy that incorporates a variety of media in a meaningful, enjoyable activity is to use technologies that allow students to follow news stories and create their own, personalized newspaper. The value to students is that they take responsibility for deciding which stories they want to follow, which engages them more in reading, and also create a professional-looking product they can be proud of. One resource that can help carry out this kind of activity is:

- » **Crayon** (<http://crayon.com>)—A free service that helps students manage news sources of interest to them on the Internet and allows them to create a newspaper to organize and display the information

For students with mild or moderate cognitive impairments, a specially-designed newspaper keeps them in touch with the

news using high-interest, low-vocabulary stories with each word accompanied by a rebus image:

- » **News-2-You** (<http://www.news-2-you.com>)—This subscription-based service prepares a weekly, downloadable current-events reader that teachers may copy and distribute to students

Other tools useful to support current events in the diverse social studies classroom include:

- » **The Big Picture** (<http://www.boston.com/bigpicture>)—Major news stories in photographs
- » **Newsmap** (<http://newsmap.jp>)—Summarizes major stories in short paragraphs and provides links to full stories
- » **Social Studies for Kids** (<http://www.socialstudiesforkids.com>)—Current events written at low reading levels

*Contributed by Dave Edyburn*

**TABLE 6 Digital Information Critiques Resources for Social Studies Education**

Sample Learning Sites	Social Studies Themes
Media Construction of War—Project Look Sharp <a href="http://ithaca.edu/looksharp">http://ithaca.edu/looksharp</a>	Theme 8: Science, technology, and society
Photo Forgery <a href="http://learning.blogs.nytimes.com/2004/03/11/photo-forgery">http://learning.blogs.nytimes.com/2004/03/11/photo-forgery</a>	Theme 8: Science, technology, and society
Don't Buy It <a href="http://pbskids.org/dontbuyit">http://pbskids.org/dontbuyit</a>	Theme 8: Science, technology, and society

**TABLE 7 Electronic Research Resources for Social Studies Education**

Sample Learning Sites	Social Studies Themes
Democratic and Republican Parties <a href="http://www democrats.org">http://www democrats.org</a> <a href="http://www.gop.com">http://www.gop.com</a>	Theme 6: Power, authority, and governance Theme 10: Civic ideals and practices
U.S. Congress <a href="http://thomas.loc.gov">http://thomas.loc.gov</a>	Theme 6: Power, authority, and governance Theme 10: Civic ideals and practices
The White House <a href="http://www.whitehouse.gov">http://www.whitehouse.gov</a>	Theme 6: Power, authority, and governance Theme 10: Civic ideals and practices
Census in Schools <a href="http://www.census.gov/dmd/www/teachers.html">http://www.census.gov/dmd/www/teachers.html</a>	Theme 1: Culture Theme 6: Power, authority, and governance Theme 10: Civic ideals and practices
Ellis Island Records <a href="http://www.ellislandimmigrants.org">http://www.ellislandimmigrants.org</a>	Theme 1: Culture Theme 2: Time, continuity, and change

## TECHNOLOGY INTEGRATION EXAMPLE 1

### ADVENTURE LEARNING

**TITLE:** Natural Resources: Sustainable Development

**CONTENT AREA/TOPIC:** History, geography, economics

**GRADE LEVELS:** 3–12

**NETS FOR STUDENTS:** Standard—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making.

**21ST CENTURY SKILLS:** Interdisciplinary Themes (Global Awareness, Environmental Literacy); Learning and Innovation Skills (Critical Thinking and Problem Solving).

**DESCRIPTION:** This integration lesson offers students the opportunity to use the *GoNorth!* Adventure Learning Series to investigate the role of natural resources and sustainable development. As Team *GoNorth!* travels throughout Chukotka, Russia, students have the opportunity to (1) understand their sense of place as it connects to their land and its resources; (2) understand the complex role of social, economic, and environmental impacts on mineral extraction and management of natural resources; and (3) understand the role of conscious consumers on sustainable development. Students will specifically investigate the concept of a “sense of place” for themselves and their parents/guardians; analyze how their actions impact the environment locally and abroad by analyzing their activity space and their actions within this space; and also analyze the relationship between social, economic, and environmental data using geospatial technologies. Students will complete these activities while also comparing their activities to the *GoNorth!* team who is bringing authentic data into their classroom via numerous media opportunities online.

**Source:** Based on *GoNorth!* Adventure Learning Series (2007). How should we handle our natural resources? - Natural Resources: Sustainable Development. <http://2007.polarhusky.com>.



Students using *Google Earth* to analyze the earth's surface.  
© iStockphoto.com

### FIGURE 2 GeoThentic Learning Environment



Source: Courtesy of *GeoThentic*, Learning Technologies Media Lab, University of Minnesota, <http://it.umn.edu>.

popular with the general public. For example, *Google Earth*, which is free and the foundation of numerous geography learning activities such as *GeoThentic* (<http://it.umn.edu/geo-thentic/>), has been downloaded more than 350 million times (Google Earth Blog, 2008). In fact, *Google Earth* is now available in 13 languages and has more than a third of the world's land surface and half of the world's population in high-resolution imagery. Google Inc. is not the only company providing new geospatial technologies—the Environmental Systems Research Institute (ESRI) has long dominated the GIS world with technologies such as *ArcGIS* and *ArcView*. Although

geospatial technologies have become widely used and access costs have declined, integration of such technologies within the classroom has been alarmingly slow. Reasons for the delay include issues such as a general lack of geographic pedagogical content models and a shortage of related curricula (Doering, Scharber, Miller, & Veletsianos, 2009; Doering, Veletsianos, & Scharber, 2007). One way that many teachers have used geospatial technologies in their classroom, especially in a one computer classroom, is with an interactive whiteboard. Check out the Hot Topic Debate feature for this chapter. Are interactive whiteboards worth the expense? Another tool that allows students to look at social studies from many different perspectives is a **Global Positioning System (GPS)**. A GPS provides users with their location and time anywhere on earth and is



commonplace in automobiles and on smart phones today. However, GPS is also used for numerous other activities such as geocaching. **Geocaching** is simply where one individual hides a cache for others to find. Gillin and Gillin (2010) note that geocaching's appeal is that it gets people out in nature at a time where the urban landscape seems to many times dominate. In education, students look at a database of caches

at numerous geocaching websites and decide on a cache to hunt for using a GPS to help them locate it. Table 8 lists good sources of other GIS and GPS lessons. Gauthier (2004) also describes a science and social studies project that uses GIS and GPS together and may be done at any grade level. See Technology Integration Example 2, which is based on Gauthier's description.

## Hot Topic Debate

### SHOULD WIKIPEDIA BE FORBIDDEN IN STUDENTS' SOCIAL STUDIES RESEARCH?

*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 2009 article "High School Research and Critical Literacy: Social Studies With and Despite Wikipedia," Harouni found that Wikipedia had become "an obstacle to learning that I felt compelled to address since it defined my students'

experience with research" (p. 473). He first noticed his students' dependence on Wikipedia as a source for their social studies reports, but realized that they neither understood well what they had quoted nor checked it for accuracy. However, he still felt Wikipedia had a role to play as a tool for making students more aware of critical evaluation of sources. Other social studies educators are not so tolerant, viewing Wikipedia as an unreliable source that should be forbidden in student work. Even Wikipedia creator Jimmy Wales says that Wikipedia is not what history students should be citing, because they should be citing history books, rather than any encyclopedia. Does Wikipedia have a role to play in student research? If so, what should that role be? Or should it be forbidden? If so, why?

**TABLE 8** Geospatial Technology Resources for Social Studies Education

Sample Learning Sites	Social Studies Themes
Our World GIS Education Book Series URLs in MEL: <a href="http://esripress.esri.com/display/index.cfm?fuseaction=display&amp;websiteID=131&amp;moduleID=0">http://esripress.esri.com/display/index.cfm?fuseaction=display&amp;websiteID=131&amp;moduleID=0</a>	Theme 3: People, places, and environments
Teaching with GIS <a href="http://www.esri.com/industries/k-12/index.html">http://www.esri.com/industries/k-12/index.html</a>	Theme 3: People, places, and environments
GIS in the Classroom: Using Geographic Information Systems in Social Studies and Environmental Science <a href="http://www.heinemann.com/products/E00479.aspx">http://www.heinemann.com/products/E00479.aspx</a>	Theme 3: People, places, and environments
Geocaching <a href="http://www.geocaching.com">http://www.geocaching.com</a>	Theme 3: People, places, and environments

## Practice of Factual Information

A more traditional, but still useful, integration strategy is having students use drill-and-practice, instructional game software, or pay-to-view Internet sites (e.g., Princeton Review's AP/SAT tutorials) to help them learn and remember important facts, such as states and capitals or dates of famous events. For example, Educational Insights' Classroom Jeopardy game (see Table 9) provides a unique and highly motivational approach to this kind of practice by placing it in the context of a quiz show game in which the whole class can participate.

At a time when so many excellent technology and curricular resources exist for social studies education, educators still need to make sure they are prepared to integrate them into their classroom. A close look at a teacher's technological, pedagogical, and content knowledge is needed.

## TECH-PACK NEEDS AND CHALLENGES IN SOCIAL STUDIES

Teachers who have sufficient social studies Tech-PACK are not only well-acquainted with the content and standards of the topics they must teach (e.g., geography and history) and the pedagogical strategies for teaching this content, they also must think automatically of the technologies that will help them carry out effective lessons to teach the content. For example, when teaching a lesson in geography about climate change, instead of simply lecturing about the current data—ice core, traditional ecological knowledge, and the melting of the Arctic ice sheets—teachers who possess Tech-PACK think about technology and how students can learn in a way that can provide an added value to learning. Thus, a teacher thinks about how students could collect climate change data for locations around the world and have students analyze change over time using a geospatial technology such as ArcGIS or Google Earth.

A teacher thinks about the relative advantage of having students use this real-time authentic data and uses various pedagogical approaches to scaffold learners to answer difficult questions. In social studies, this presents several unique challenges to teachers striving to integrate technologies into their teaching. These challenges are discussed here from the perspective of each of the separate Tech-PACK components.

### Social Studies Content Knowledge

The field of social studies presents a unique array of special problems related to teachers' content knowledge. First, social studies is such a broad content area that most teachers who obtain degrees in it must take courses in many different content areas ranging from geography to civics. This is especially true for middle school teachers, although high school teachers

## TECHNOLOGY INTEGRATION EXAMPLE 2

### GEOSPATIAL TECHNOLOGIES

**TITLE:** *GeoThentic*: Where is the best place to build a hospital in San Francisco?

**CONTENT AREA/TOPIC:** Technology, history, geography, economics

**GRADE LEVELS:** 4–12

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Interdisciplinary Themes (Global Awareness, Environmental Literacy); Learning and Innovation Skills (Critical Thinking and Problem Solving); Information Media and Technology Skills (Media Literacy); Life and Career Skills (Social and Cross-Cultural Skills).

**DESCRIPTION:** This integration lesson offers students the opportunity to analyze socio-scientific data to identify the best location to build a new hospital within the San Francisco region using geospatial technologies. Analyzing data ranging from liquefaction, earthquake frequency, population density, and population income, learners need to identify the best location to build a new hospital, and more importantly, provide a justification for their location based on their analysis.

**Source:** Based on University of Minnesota Learning Technologies Media lab (2010). *GeoThentic*: San Francisco Learning Module. <http://www.geothentic.umn.edu>.

with degrees in one area (e.g., history) are frequently called on to teach another social studies area such as geography or economics. Increased economic pressures on schools have resulted in a decrease of specialty-area social studies teachers and an increase in “multi-purpose” ones: teachers trained in one social studies discipline being asked to teach other topics under the social studies umbrella. Thus, it is not surprising that social studies teachers often find their content knowledge preparation insufficient to the topics they are asked to teach.

Another characteristic of social studies that presents special problems is the rapidity with which the content changes. Teachers who were well prepared to teach in history or geography upon graduation quickly find their content knowledge out-of-date. Choosing the best materials and technology tools to support instruction for their area means they must also constantly keep updated on their content knowledge so they can identify up-to-date, accurate resources. Keeping updated means attending numerous professional development

opportunities, attending conferences, and readily available personal research (see Table 10).

## Social Studies Pedagogical Knowledge

Since pedagogical knowledge is often specific to the content area, teachers also frequently struggle to create best strategies to teach topics that may be somewhat or largely unfamiliar to them. Each of the social studies content areas presents special pedagogical challenges. For example, history requires strategies that engage students and combats their tendency to think of it as uninteresting and irrelevant to current issues and problems. Geography requires strategies that help students visualize spatial concepts and apply them to their own surroundings. Civics instruction often uses community projects and special speakers to emphasize how concepts apply to students' lives. All these strategies may be supported

and facilitated with technologies, but teachers first must be aware of the basic pedagogies associated with best practice for each social studies topic (see Table 11).

## Social Studies Technology Knowledge

The use of technology within the social studies has the potential to transform the learners' experiences. Teachers need to acquire technological knowledge to allow students to learn with and from technology. Teachers need to know about the technology and how to use the technology that affords learning specific concepts and strategies within their classroom. Within any content area, the technology knowledge is many times content and surely pedagogically specific.

Social studies teachers have many technologies at their disposal to help teach social studies topics. Some are specific to the topics, but some are general materials that could be

**TABLE 9** Factual Information Resources for Social Studies Education

Sample Learning Sites	Social Studies Themes
Educational Games <a href="http://www.sheppardsoftware.com">http://www.sheppardsoftware.com</a>	Theme 3: People, places, and environments

**TABLE 10** Social Studies Content Knowledge Resources

Sample Learning Sites	Location
National Council for Social Studies	<a href="http://www.socialstudies.org">http://www.socialstudies.org</a>
National Council for Geographic Education	<a href="http://www.ncge.org">http://www.ncge.org</a>
Social Studies Resources	<a href="http://www.sfsocialstudies.com">http://www.sfsocialstudies.com</a>
PBS Social Studies	<a href="http://www.pbs.org/teachers/socialstudies">http://www.pbs.org/teachers/socialstudies</a>
National Geographic Society Alliance Network	<a href="http://www.ngsednet.org/communities">http://www.ngsednet.org/communities</a>

**TABLE 11** Social Studies Pedagogical Knowledge Resources

Sample Learning Sites	Location
<i>GeoThentic</i>	<a href="http://lt.umn.edu/geothentic">http://lt.umn.edu/geothentic</a>
National Council for Social Studies Resources	<a href="http://www.socialstudies.org/resources">http://www.socialstudies.org/resources</a>
National Curriculum Standards for Social Studies	<a href="http://www.socialstudies.org/standards">http://www.socialstudies.org/standards</a>
Powerful and Authentic Social Studies	<a href="http://www.socialstudies.org/pass">http://www.socialstudies.org/pass</a>
Annenberg Media	<a href="http://www.learner.org">http://www.learner.org</a>

used in many different content areas. For example, teachers who want their students to learn about the temporal aspects of history may immediately turn to the software *TimeLiner*. However, instead of using a content-specific technology, a teacher may teach their students to use a concept-mapping program to create a timeline from their research, achieving the same result. Moreover, a teacher hoping their students can learn about geospatial analysis should immediately think about using a geographic information system such as *ArcGIS*.

Teachers need to “know what they don’t know” regarding technology in their content area. Research is required to acquire this knowledge, along with time and professional development to understand the procedural knowledge of using the technology (see Table 12). The Top Ten Feature showcases ten great ways for integrating technology in social studies instruction.

## Strategies for Improving Tech-PACK in Social Studies Instruction

Strategies for improving Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

### 1. Do I have the social studies content knowledge needed to assist my students in meeting the standards within my classroom?

If a teacher does not have the necessary content knowledge, they may consider attending additional social studies university courses, attending local social studies workshops, attending professional conferences such as the National Council for the Social Studies and the National Council for Geographic Education, and/or working with a mentor who can assist in knowledge development.

### 2. Do I have the technological knowledge needed to teach the social studies content within my classroom?

One of the struggles with technological knowledge is that there are so many technologies that teachers need to be constantly aware of as options for their teaching and technology learning take a great deal of time. Teachers need to be motivated to find these technologies, have the confidence to learn them, and then ultimately, use them in their classroom. Learning and teaching with technology can be fun and rewarding, but it does take time. Teachers need to take this time and schools need to provide the professional development opportunities.

### 3. Do I have the pedagogical knowledge needed to teach the social studies content within my classroom?

Teachers need to be able to take their content and technology knowledge, meld them together, and be able to draw from multiple pedagogical models based on their classroom context to teach their students. For teachers to improve their pedagogical knowledge, they need to be given the opportunity to work with a mentor who has the content and technology knowledge, attend professional development opportunities, and be given the “license to fail.” What is meant by a license to fail is that administrators need to allow teachers to try new technological and pedagogical approaches, even when they are not always successful. If teachers are not given the opportunity to try new and innovative approaches, progress and advancement will not occur.

As part of the end of chapter materials, you will deconstruct a teacher’s Tech-PACK based on what you know of their knowledge and what must be learned to teach social studies effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on what you would want in your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone.

**TABLE 12** Social Studies Technological Knowledge Resources

Sample Learning Sites	Location
<i>GeoThentic</i>	<a href="http://lt.umn.edu/geothentic">http://lt.umn.edu/geothentic</a>
Digital Age: Technology-Based K-12 Lesson Plans for Social Studies	<a href="http://www.socialstudies.org/publications/books">http://www.socialstudies.org/publications/books</a>
Digital Geography: Geospatial Technologies in the Social Studies Classroom	<a href="http://www.infoagepub.com/index.php?id=9&amp;p=p473c94ace3ef3">http://www.infoagepub.com/index.php?id=9&amp;p=p473c94ace3ef3</a>



Take advantage of these ten powerful strategies for using technology to enhance the teaching of social studies topics.

SOURCE	TRACK	SELECTION
Integrate adventure learning and provide students with opportunities to collaborate with other students, teachers, and experts	<b>1</b>	Students use a research-based curriculum as they study authentic real-time adventures taking place around the world. Students learn from the curriculum and each other as they are part of an unfolding narrative.
Take virtual field trips and help students learn about other cultures	<b>2</b>	The wealth of information and images available about other cultures enriches students' study of other lands and ways of life.
Send students on a geocaching treasure hunt with GPS devices	<b>3</b>	These motivating activities get students to spend more time studying geographical information and techniques.
"Live through" history with Muzzy Lane's simulated immersion experience	<b>4</b>	Students play the role of decision maker in historical situations in order to see the relevance of these events in their daily lives and to develop better problem-solving skills.
Do webquests to learn the history behind political issues	<b>5</b>	Students do Internet research to learn that current issues have historical roots in past events and debates.
Integrate geospatial technologies to study the earth, people, and the symbiotic nature between the two	<b>6</b>	Geospatial technologies such as <i>ArcGIS</i> and <i>Google Earth</i> allow for real-world analysis as students study content such as history, economics, and geography.
Students learn economic principles with stock market simulation game	<b>7</b>	The complexities of the stock market become easier to understand when students play the role of stockbroker, investing "their own" money and seeing the return over time.
Teach local and other history with electronic storytelling	<b>8</b>	Images and audio make the stories of lives, events, or eras come alive for students and play a key role in helping students prepare oral histories.
Use software such as <i>VoiceThread</i> to allow for real-time collaboration around numerous forms of content	<b>9</b>	This kind of hands-on software allows students to post content (e.g., photos, videos, PDFs) and comment on each other's work in an online learning environment.
Use digital cameras to explore community-based history and current issues	<b>10</b>	Digital photography allows students to capture images from their vantage point, participate in the construction of knowledge, and learn how diverse perspectives can be shaped.





# SUMMARY

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

**1. Issues and Problems in Social Studies Instruction**—There are many exciting opportunities in social studies instruction, and many challenging issues. Issues range from how to address the plethora of social studies standards, to the dilemma of teaching social studies effectively, to the perils of the information explosion.

**2. Technology Integration Strategies for Social Studies Instruction**—There are numerous strategies that can be used to teach social studies. These strategies range from graphic

representations to adventure learning to the use of geospatial technologies. Teachers need to be aware of these many proven approaches to social studies instruction.

**3. Tech-PACK Needs and Challenges in Social Studies Instruction**—Teachers need to be able to evaluate their technological, pedagogical, and content knowledge and know how they can improve their knowledge domains to become the most effective teacher possible.



## ISSUES

### for Collaborative Discussion and Reflection

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

**1.** Harp's 1996 article, "The History Wars," described the conflict that resulted when some historians proposed altering the "traditional" treatments of American and world history to include emphasis on multicultural influences. He said, "While some are still fighting hard for a set, traditional curriculum—with standards to match—technology has opened the history classroom door to a dizzying array of data, artifacts, and perspectives. Helping teachers to make sense of it all is more than half the battle." What role has technology played in causing "the history wars"? What needs to be done to help teachers "make sense of it all"?

**2.** Bolick (2008) notes in her article, "Technology Integration: The Trojan Horse for School Reform," within the "Research on Technology in Social Studies Education" that there is no "substantive basis in the literature that proves that technology integration will lead

to school reform" (p. 173). This is even after decades and millions of dollars have been invested into technology within K-12 schools. If this is indeed what the research shows and there are so many contradictory technology integration agendas, how should school districts and teachers move forward with technology integration and why should they if research illustrates this notion?

**3.** The National Council for the Social Studies said, "Powerful social studies teaching is integrative across time and space, connecting with past experiences and looking ahead to the future. It helps students appreciate how aspects of the social world function, not only in their local community but also in the past and in other cultures" (1994, p. 33). What are some ways in which technology can enable teaching strategies with these characteristics?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
    - » Wikis
    - » Blogs
    - » Social networking sites
    - » Internet searching
    - » Distance education
    - » Videoconferencing
    - » Internet research
    - » Internet navigation
  - b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
  - c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.
- a. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
    - » What is the relative advantage of using the technology(ies) in this lesson?
    - » Reflect on, assess, and describe your Tech-PACK for this situation.
  - b. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
    - » What are the objectives of the lesson plan?
    - » How will you assess your students' accomplishment of the objectives?
    - » What integration strategies are used in this lesson plan?
    - » How would you prepare the learning environment?
  - c. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
  - d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
  - e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Ms. Webb is an eleventh grade geography teacher who has always faced several challenges in teaching the human/environmental interaction theme of the National Geography Standards. For example, she always wanted students to be able to analyze the impact of population growth and urban sprawl on their local community. Ms. Webb has a master's degree in geography, so her content knowledge was extremely strong. She felt like she definitely knew the content of geography because it was not only what she received her master's degree in, but it was her major concentration as a pre-service social studies major. Unlike the majority of her classmates who majored in history, she followed her love—geography. Ms. Webb realized she needed to learn more about how she could have students do this type of human/environmental interaction with technology. She had heard about geospatial technologies, but unfortunately she received her degree in social studies education and her master's in geography before it was a major focus of these programs. She resolves to attend professional development workshop to assist her in using technology. She has also recently purchased a BlackBerry PlayBook and realized*

that ESRI has numerous applications that work with this tablet computer.

- a. Deconstruct Ms. Webb’s Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic

you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



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.



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# TEACHING AND LEARNING WITH TECHNOLOGY IN MUSIC AND ART INSTRUCTION

# TEACHING AND LEARNING WITH TECHNOLOGY IN MUSIC AND ART INSTRUCTION

The innovative cities of the coming age will develop a creative union of technology, arts and civics.

Sir Peter Hall (1998), renowned geographer and authority on the economic, demographic, cultural, and management issues facing cities

## o u t c o m e s

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

1. Articulate a rationale for including technology in curriculum for arts education.
2. Recognize the implication for technology integration of each current issue faced by music teachers.
3. Create key strategies for integrating technology into music education curricula.
4. Recognize the implications for technology integration of each current issue faced by art teachers.
5. Create key strategies for integrating technology into art education curricula.
6. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to music and art teachers.



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## key terms

auto-tuning  
computerized kiln  
morphing  
Music Educators National  
Conference (MENC)

Musical Instrument Digital  
Interface (MIDI)  
music literacy  
notation software  
sequencer

tweening  
vocal processing  
software



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## TECHNOLOGY INTEGRATION IN ACTION: THE FINE ART OF ELECTRONIC PORTFOLIOS

GRADE LEVELS: Middle to high school • CONTENT AREA/TOPIC: Music and art composition, technology • LENGTH OF TIME: Ongoing

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

The music, arts, and technology resource teachers at Eureka High School were discussing the new block scheduling plan in which music, art, and technology credits would share one of the four 90-minute units students would attend each day. The teachers realized that a logical thread among these three curricula would be to have students develop a web-based portfolio of their music and art. They felt this would meet several needs. First, it would be a way of working with each student at individual levels of musical and artistic expertise. This was important because students in their classes would range from beginners at musical composition or art skills to advanced musicians or artists who were active in choir, band, orchestra, and/or art studios. Second, it had always been difficult to find an audience for student work; the teachers knew that having others view their work was motivating and provided helpful feedback to students at all levels. A web-based format would make it easier to share students' works. Third, it would be

easy to create projects that linked skills across the disciplines—for example, having students use a **Musical Instrument Digital Interface (MIDI)** keyboard and music editor to prepare a musical composition expressing the feeling or mood of a painting. (MIDI refers to a standard that has been adopted by the electronic music industry for controlling devices, such as synthesizers and sound cards.) Finally, the teachers realized that an electronic portfolio could serve as a valuable, ongoing assessment tool for students' art, music, technology, and language development, and would help students develop skills in using technology to present their work and to communicate and share information with others.

#### Step 2: Assess Tech-PACK.

Prior to the beginning of the project, the resource teachers realized they should assess their own technological, pedagogical, and content knowledge (Tech-PACK), so they could evaluate their strengths and weaknesses and understand where they might locate themselves within the Tech-PACK model.

**Content Domain.** All three teachers felt very comfortable and knowledgeable with their content knowledge. They had all been teaching nearly ten years and had attended numerous



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professional development opportunities over the years to enhance their content knowledge.

**Pedagogy Domain.** Much like the content domain, all three teachers felt as if they knew how to teach their content very well. They all had multiple pedagogical strategies to engage students at all levels.

**Technology Domain.** Only the art teacher felt lacking in his technology knowledge and how to effectively use web-based and image-editing tools within the classroom. As the three discussed their weaknesses and strengths, it was refreshing for them to see how they could help each other to be at the center of the Tech-PACK model. They decided they would move forward together to make it a success for their students.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

The teachers decided they each would use a component of the portfolio as the basis of student assessment each grading period. The art and music teachers would assign each student individual benchmarks to achieve in their composition and skill development, and the technology teacher would use the website the students produced to assess their production skills. Students' grades would be a combination of the three assessments, with each content area weighted according to which one was being emphasized during the grading period. They

decided on the following outcomes, objectives, and assessment strategies:

- » **Outcome:** Progress in art. **Objective:** Students will meet their assigned benchmark for progress in art skills. **Assessment:** Rubric to assess this portfolio component.
- » **Outcome:** Progress in music. **Objective:** Students will meet their assigned benchmark for progress in music skills. **Assessment:** Rubric to assess this portfolio component.
- » **Outcome:** Progress in language expression. **Objective:** Students will meet their assigned benchmark for development in written expression. **Assessment:** Rubric to assess this portfolio component.
- » **Outcome:** Technology skills. **Objective:** Students will demonstrate competence in each required web page development skill by completing assigned tasks. **Assessment:** Web production checklist.

### Step 4: Design integration strategies

The teachers decided they would follow the same sequence of activities for each grading period:

- » **Review skill levels and set benchmarks:** The art and music teachers meet with each student, review accomplishments to date, and set benchmarks for individual skill development. Some students with lower skill levels are placed in small groups so that teachers can spend more time working with them.
- » **Review portfolio requirements:** The technology teacher meets with each student, reviews the requirements for the portfolio, and sets tasks and expectations to assist students to develop a more clear and aesthetically pleasing presentation.
- » **Decide on projects:** A different project is set for each grading period. For example, for the first project, the teachers decide to have students use their MIDI keyboards and notation software to write a musical composition based on the music of a period they have been studying in their history classes. Then the students use image manipulation software to create a collage of colors and images that come to mind as they listen to the music composition they or their fellow students have created. The technology teacher helps them add their sound and graphics creations to their portfolios.

## THE ARTS IN THE INFORMATION AGE

Many arts educators have resisted pressure to use computers and other instructional technologies, complaining about the contradiction inherent in blending impersonal machines with traditionally humanistic endeavors. In reality,

however, technology has always played a part in the arts. Over the centuries, technology has provided tools, materials, and processes that aided artists' creative expression. In more recent times, the phonograph in music and the camera in visual arts have changed people's definitions of art. The integration of computers and other forms of electronic technology represents the next logical step in the evolution of the arts.

» **Determine group presentations:** Each teacher identifies whole-group presentations that they need to offer. For example, the music teacher needs to demonstrate techniques with the MIDI keyboard and music notation software. The art teacher designs a presentation on how to use layering techniques in Adobe *Photoshop* to create a graphic collage. The technology teacher develops demonstrations of video and audio editing techniques. After their group presentations, the teachers work with each student as needed to complete the required products.

» **Arrange reviews and final presentations:** The teachers arrange for various experts in other locations to do online reviews of the students' creations and to give them feedback. Students will revise their products as time permits and as they feel appropriate. The teachers arrange for an "Evening at Eureka" to be given at the end of the grading period, at which computers would be set up in a lab to display each student's work. Parents and friends are to be invited via the school website and via desktop-published invitations created by the art students.

### Step 5: Prepare instructional environment

The technology teacher created a main page for the student portfolios, with links to each student's work. He also created a link from the school's main page to the portfolio section. The music teacher had a MIDI keyboard classroom, but there aren't enough keyboards for each student to have one for a whole period. The teachers arranged the schedule so that half the class attended band, choir, or orchestra practice, worked in the art studio, or worked on their individual portfolios in the computer lab, while the other half worked on composition.

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results

At the end of each grading period, the teachers reviewed the students' portfolios, assessed progress, and discussed ways to make the work go more smoothly. Some of the questions they asked were:

» Did most students meet the individual benchmarks set for them?

- » Were students actively engaged in the project work?
- » Did the group demonstrations provide adequate initial instruction before students began work on their own?
- » Were the classrooms and lab times organized for efficient work?

### Step 7: Make revisions

The teachers were gratified to see that most students seemed motivated by the idea of using a multimedia web format to display their work and were making good progress on their benchmarks. However, it was apparent that many students needed more individual instruction than the demonstrations could provide. The teachers decided to videotape a series of short demos so that students could view them individually or in small groups, as needed, after the initial presentation. They agreed that the scheduling proved to be a challenge. They decided to request that additional MIDI keyboards and software be obtained to support this work. Also, English and history teachers approached them about coordinating the portfolio work with students' writing and research projects. The teachers agreed to work together to merge these skill areas into students' portfolio assessments.

**Source:** Based on concepts from Duxbury's article "Make Sweet Music with Electronic Portfolios" in *Learning and Leading with Technology*.



With software like *Photoshop*, students can manipulate and edit photos and images in a professional format.  
Photo by Learning Technologies Media Lab, University of Minnesota.

Many educators and members of the community question the need for instructional technology in the arts curriculum. Even some proponents of technology applications in other disciplines balk at investments in technology for the arts.

However, academics like Peppler (2010) when discussing the role of arts education in the digital age noted that "there are three broad concepts that are important to the creation of media art." These concepts include active engagement; a

personal connection to the task to inspire learning; and the development of art that brings value to their community.

She also noted that "as educators are struggling to keep up with changing demands of this new digital era, new literacy theorists argue that our very definition of literacy is expanding to include any type of communicative interaction involving speaking, reading, listening, drawing, and writing with text in print and non-print forms" (p. 7). Another

version of this view is posted on The National Association for Music Education website (<http://www.menc.org>). When describing the issues raised by the National Standards for Arts Education, it states that the standards insist on the following:

That the transforming power of technology is a force not only in the economy but in the arts as well. The arts teach relationships between the use of essential technical means and the achievement of desired ends. The intellectual methods of the arts are precisely those used to transform scientific discovery into technology.

For the arts, technology thus offers means to accomplish artistic, scholarly, production, and performance goals. But the mere availability of technology cannot ensure a specific artistic result: the pencil in a student's hand ensures neither drawing competency nor a competent drawing. Nor, by itself, will exchanging the pencil for an airbrush or a computer graphics program create a change in the student.

## ISSUES AND PROBLEMS IN MUSIC INSTRUCTION

Music and technology have always had a unique relationship. From the early history of music to the technological advances of today, many tools have been developed that afford musicians, teachers, and/or students the opportunity to experience, develop, play, and critique music. However, there are several issues and problems related to music education in general, as well as the use of technology in the classroom for teaching music. These issues and problems are explored in this section.

### Redefining Music Literacy

In music education, the term **music literacy** usually means an ability to read standard music notation. But the computer enables—if not encourages—experimentation with alternative ways to represent music. The earliest **sequencers**, even those with notation capability, have always included a “graphic” or “matrix” editor, a window in which the user could edit music by dragging, deleting, or expanding small rectangles on a grid. Composer Morton Subotnick authored *Making Music*, a software package that allows children to draw lines that are then rendered into melodies with a similar contour. More recently, Tod Machover of the MIT Media Lab has developed numerous projects for children and adults, such as *Hyperscore*, that require no formal training or music literacy.

Today, the desktop music production software industry (e.g., Apple, Emagic, Cakewalk, Propellerheads, Cubase)

is helping accelerate a trend away from reliance on printed sheets and toward a sound artifact. This means that many students who are discouraged by a requirement to learn notation-based theory can now participate in the school music program as both composers and performers with little, if any, ability to read music.

### Training Teachers to Meet Music Standards

Until states begin requiring that teacher candidates demonstrate proficiency with technology, teacher preparation programs will have a difficult time making a case for including required technology courses in their curricula. Teacher preparation programs, already overloaded with content, would be reluctant to displace a more traditional course with one whose skills remain in the “optional” category with respect to licensure.

However, professional organizations are working hard to develop standards to guide teacher development with the hope that these standards will provide the guidelines needed for uniformity. Table 1 lists music technology and music education standards.

### Downloading of Music Illegally

Since the days of bulletin board services and software like *Napster*, *Pirate Bay*, and *LimeWire* (currently under a court ordered injunction to stop distributing their software) that allow peer-to-peer sharing of files, downloading music illegally has been a concern of the music industry. The sharing of files was extremely popular in the late 1990s and early 2000s, and numerous court cases have surrounded this issue. In Minnesota, a woman was fined \$1.9 million for downloading 24 songs illegally (Friend, 2009). The sharing of files is so readily available today that many students don't view the downloading of music as illegal.

The most recent data, however, reveal a changing trend. Moya (2010), describing the latest statistics on music users, noted that total music spending has dropped by 19% and that the number of people buying digital music has declined to 34.6 million from 35.2 million. Teenagers' practices are also changing as they have downloaded 19% less music, either legally or illegally since 2008. The trends reveal that teenagers and others are opting for online music streaming, such as Pandora.

### The Intersection of Popular Music, Technology, and Music Instruction

The **Music Educators National Conference (MENC)** published a collection of essays addressing the issue of

**TABLE 1** Standards in Music Technology and Music Education

<b>Areas of Competency in Music Technology</b> <a href="http://www.ti-me.org/index.php/professional-development/competencytech-areas">http://www.ti-me.org/index.php/professional-development/competencytech-areas</a>	<b>MENC Standards</b> <a href="http://www.menc.org/resources/view/national-standards-for-music-education">http://www.menc.org/resources/view/national-standards-for-music-education</a>
<ol style="list-style-type: none"> <li>1. Electronic musical instruments (keyboards, controllers, synthesizers, samplers, sound reinforcement equipment)</li> <li>2. Music production: data types (MIDI, digital audio); processes (sequencing, looping, signal processing, sound design)</li> <li>3. Music notation software</li> <li>4. Technology assisted learning (instructional software, accompaniment/practice tools, Internet-based learning)</li> <li>5. Multimedia: authoring (web pages, presentations, digital video); digital image capturing (scanning, still/video camera); Internet; electronic portfolios</li> <li>6. Productivity tools, classroom and lab management: productivity tools (word processing, spreadsheet, database); computer systems (CPU, I/O devices, storage devices/media); lab management systems; networks</li> </ol>	<ol style="list-style-type: none"> <li>1. Singing, alone and with others, a varied repertoire of music</li> <li>2. Performing on instruments, alone and with others, a varied repertoire of music</li> <li>3. Improvising melodies, variations, and accompaniments.</li> <li>4. Composing and arranging music within specified guidelines</li> <li>5. Reading and notating music</li> <li>6. Listening to, analyzing, and describing music</li> <li>7. Evaluating music and music performances</li> <li>8. Understanding relationships between music, the other arts, and disciplines outside the arts</li> <li>9. Understanding music in relation to history and culture</li> </ol>

Source: Standards reprinted by permission of TI:ME and MENC.

popular music. “Bridging the Gap: Popular Music and Music Education” made very little mention of popular music’s heavy reliance on technology for both production (composition) and live performance (Rodriguez, 2003). Any music teacher seeking to start and sustain a program component dedicated to rock, hip hop, or other pop genres must have (or have access to) extensive knowledge of desktop music production and live sound reinforcement—not to mention a credible familiarity with pop music’s complex web of music, culture, and traditions.

### The Music Director as Small Business Administrator

A typical secondary school music program involves hundreds of students, rooms full of instruments and other equipment, wardrobes of uniforms and choral robes, libraries of sheet music, methods books and other print resources, and large budgets. The music director usually oversees the largest inventory of physical assets outside the athletic department. The music director is responsible for tracking students’ academic progress and other duties common to all classroom teachers. In addition, the music director must be his or her own director of development, constantly on the lookout for continuing or increased funding. All of these issues make knowledge of information management software a high priority—if not a stated requirement—for the efficient operation of a successful music program.

## TECHNOLOGY INTEGRATION STRATEGIES FOR MUSIC INSTRUCTION

In a superb review of research related to technology and music learning, Webster (2002) identified several categories of music experience that have been the focus of technology integration that are still excellent guidelines today, including music listening, performance, and composition. He also acknowledged the crucial role that technology plays in research and assessment within the educational environment. In addition to general-purpose software (e.g., word processing, spreadsheet, web authoring), two broad categories of computer-based tools play a primary role in serving the needs of music teachers: instructional software (programs developed primarily for teaching music skills) and music production software (programs that facilitate music composition, recording, and performance). The Top Ten Feature showcases ten great ways for integrating technology into music and art instruction.

The first step in the process of integrating music technology may well be the purchase of an electronic keyboard or a synthesizer. For financial reasons, many schools that have to choose between a computer lab or a keyboard lab for their music programs choose the latter. Another relatively recent entry into the music performance realm is the “intelligent” accompaniment system (*SmartMusic*). With a library





Take advantage of these ten powerful strategies for using technology to enhance the teaching of music and art.

SOURCE	TRACK	SELECTION
<b>Music Strategies</b>		
Students use software like Apple's <i>GarageBand</i> as a personal recording studio	<b>1</b>	Students have the flexibility and resources they need to support their own creative musical explorations.
Teachers use an electronic keyboard lab to develop students' skills in keyboarding, theory, and harmony	<b>2</b>	Networked systems allow the teacher to monitor individual students as they build their skills.
Software such as <i>Practica Musica</i> serves as a tutorial in music fundamentals	<b>3</b>	Interactive software gives students hands-on practice in music theory and ear training.
MuseScore is a free, cross-platform music notation program	<b>4</b>	This program offers a cost-effective alternative to professional programs such as <i>Sibelius</i> and <i>Finale</i> .
Students build a website to help teach music history	<b>5</b>	The wealth of images and information on the Internet gives students the material they need to research composers, compositions, and periods of musical history and to share their findings on the web.
<b>Art Strategies</b>		
Students take virtual field trips to art museums	<b>6</b>	Through virtual tours available at many sites, students can "visit" museums and see great works of art that serve as illustrations of artists' work and models for their own work.
Students create electronic portfolios to illustrate their creative products	<b>7</b>	<i>PowerPoint</i> presentations, videos, electronic books, and websites offer versatile venues for students to document and share their work.
Illustrate artworks/techniques with digital slide shows	<b>8</b>	Teachers can store large collections in very little space and show parts of collections to illustrate techniques and products of various artists.
Teacher-created websites give short tutorials on art concepts	<b>9</b>	The Internet offers an easy, motivating way to let students develop background knowledge of art concepts on their own.
Students create an illustrated desktop-published brochure or newsletter	<b>10</b>	This activity is a great way for students to practice writing as well as visual design skills.

of over 30,000 compositions at the time of this writing, students can select a piece from either the ensemble or solo literacy and practice with an accompaniment system that follows their performance as tempo is varied for expressive

purposes. In a school or university with little or no budget to provide accompanists, such technologies provide significant opportunity. Strategies that make use of all these resources include support for music composition and production,

music performance, self-paced learning and practice, teaching music history, and interdisciplinary strategies. These are summarized in Table 2 and discussed next.

## Support for Music Composition and Production

For the purposes of this chapter, music production and music composition mean the same thing. The three essential tools in this process are sequencers, notation, and vocal processing software, and each can contribute substantially to teaching both production and performance. Sequencers allow the user to record, edit, and play back digital audio and MIDI data. Notation programs generally have fewer recording and playback options but offer more flexibility in score and page setup, part extraction, text formatting, and



Desktop music systems have prompted new definitions of musicianship that recognize alternative tracks to musical creativity. Photo by Learning Technologies Media Lab, University of Minnesota.

**TABLE 2** Summary of Technology Integration Strategies for Music

Technology Integration Strategies	Benefits	Sample Resources and Activities
Support for music composition and production	<ul style="list-style-type: none"> <li>Offers a range of mixing and sound design options to support composition for students of any age</li> <li>Supports both traditional and nontraditional composition</li> <li>Offers teachers maximum flexibility in designing music curriculum</li> </ul>	<ul style="list-style-type: none"> <li>Apple/Emagic <i>Logic</i> <a href="http://www.apple.com/logicstudio">http://www.apple.com/logicstudio</a></li> <li>Apple's <i>GarageBand</i> <a href="http://www.apple.com/ilife/garageband">http://www.apple.com/ilife/garageband</a></li> <li>Reason (<i>Propellerhead</i>) Software <a href="http://www.propellerhead.se">http://www.propellerhead.se</a></li> <li><i>BubbleMachine</i> <a href="http://www.lipscomb.umn.edu/bubblemachine">http://www.lipscomb.umn.edu/bubblemachine</a></li> </ul>
Support for music performance	<ul style="list-style-type: none"> <li>Expedites preparation for performance (e.g., rearranging music for alternate instrumentations, re-creating lost or missing parts from the score, transposing parts, and simplifying difficult passages)</li> <li>Helps teachers with theory lessons, quizzes, and other handouts to aid student performance</li> </ul>	<ul style="list-style-type: none"> <li><i>Sibelius</i> <a href="http://www.sibelius.com">http://www.sibelius.com</a></li> <li><i>Finale</i> and <i>Print Music</i> software <a href="http://www.finalemusic.com">http://www.finalemusic.com</a></li> <li><i>MidiNotate</i> <a href="http://www.notation.com">http://www.notation.com</a></li> </ul>
Support for self-paced learning and practice	<ul style="list-style-type: none"> <li>Offers individual, personal help with needed skills, ear training, or music theory</li> </ul>	<ul style="list-style-type: none"> <li><i>Practice Musica</i> <a href="http://www.ars-nova.com">http://www.ars-nova.com</a></li> </ul>
Support for teaching music history	<ul style="list-style-type: none"> <li>Internet sites provide easy-to-access background information on composers and musical periods/compositions</li> <li>Website generation offers a venue for students to share their research</li> </ul>	<ul style="list-style-type: none"> <li>Classic Motown timeline <a href="http://classic.motown.com/timeline/">http://classic.motown.com/timeline/</a></li> <li>Internet Public Library 2 <a href="http://www.ipl.org/div/mushist">http://www.ipl.org/div/mushist</a></li> <li>See also <a href="http://pbs.org">pbs.org</a> for other interactive and educational timelines and music history resources</li> </ul>
Support for interdisciplinary strategies	<ul style="list-style-type: none"> <li>Builds on natural relationships between music and other topics (e.g., physics)</li> <li>Helps promote musical literacy while teaching related concepts</li> </ul>	<ul style="list-style-type: none"> <li>Math &amp; Music <a href="http://www.fun-books.com/books/toc/Math_and_Music_Features.htm">http://www.fun-books.com/books/toc/Math_and_Music_Features.htm</a></li> </ul>

other print-related issues. In other words, a sequencer facilitates music making in the aural domain, whereas notation facilitates music making in the visual domain. **Vocal processing software** is to voice audio what word processing software is to text. It allows users to make changes to the pitch and create interesting vocal distortions. *Auto-Tune* by Antares is the premier software of this kind. It was created by Andy Hildebrand, an engineer working on seismic data, who suddenly realized this type of software had vocal-editing potential. This software allows a unique vocal distortion technique called **auto-tuning**.

All three of these programs allow students to compose music in both traditional and nontraditional ways. With these tools, they can enter music with the mouse, play it with a MIDI-equipped keyboard or other input device (e.g., guitar or wind controller), or import it by opening standard MIDI files created by others (e.g., their fellow students, their teachers, or files found on the Internet). Designed primarily for desktop music production, the sequencer typically offers more options for creating a sonic artifact: more sophisticated mixing and sound design features. Notation software is designed primarily to facilitate the production of music as a visual artifact, music on paper or on screen that can then be performed by a live musician. Note, however, that almost all sequencers now offer at least a basic notation component, and notation software programs are giving the user more and more playback options.

Music production software includes sequencing (MIDI and digital audio), digital audio editing (often a component of a sequencing program), and music notation. Although these programs offer teachers maximum flexibility in designing curriculum, they require more involvement from the teacher in creating curricula, directing instruction, assessing, training, and technological maintenance.

Sequencers are available in both hardware and software form. The hardware sequencer is usually found as an integrated component of a synthesizer workstation—a synthesizer with the ability to record multiple tracks of MIDI information. Software sequencers run as an application on a computer and therefore require a more complete MIDI workstation (computer, MIDI controller, sound module, and a MIDI interface) but are exponentially more powerful, with increased processing speed, storage capacity, and a bigger screen on which to display data.

Most sequencing programs simulate the functions of the physical recording studio. Music is recorded on tracks and assigned to channels for playback and editing. Software plug-ins are digital equivalents of outboard (hardware) signal modifiers such as echo chambers and compressors and, depending on the processing power of the computer being used, provide the composer with a desktop recording studio equipped with virtually unlimited mixing options. Many

sequencers offer the ability to record sound directly onto the computer's hard drive with the use of a microphone. Live, simultaneous multichannel recording is possible with an external digital audio interface. After recording, digital audio data, as represented by a wave shape, can be manipulated (edited) with the ease and precision of text in a word processor.

With very few exceptions, all sequencers support both step- and real-time recording of MIDI data. Once MIDI notes are entered, they can be edited like any other data on the computer: cut, copied, and pasted. All performance parameters of MIDI data can be controlled by the user independently of one another—including pitch, tempo, volume, and dynamics.

Some programs designed for young children have sequencing components that enable composition. The “Doodle Pad” component of *Music Ace*, for example, allows the user to drag different-shaped happy faces (representing notes of different rhythmic values) onto a staff. In addition, the user can assign each note to one of several different sounds (e.g., piano, violin) as represented by a different color. With proper direction, however, elementary school students can be taught the basic operations of even the most sophisticated professional software (see Technology Integration Example 1).

Projects that begin at a computer workstation in a lab can be used in other situations throughout the music program. Students can create notation files that are then used to facilitate performance in the rehearsal room or at a concert. Students who are especially proficient on an instrument (including voice) can create a sequenced instrumental “bed” to accompany a live performance or group or individual rehearsal.

Desktop music systems (e.g., the MIDI sequencer) have prompted new definitions of musicianship that recognize alternative tracks to musical creativity, as well as the traditional conservatory model of preparation. As suggested earlier, students with little or no “formal” musical training or keyboard skills can create and edit compositions using a sequencing program with step-entry capability. Students can also perform analyses of music using pre-existing MIDI files and/or digital audio imported from a CD. Once the pieces have been imported into a sequencer, students can explore all aspects of musical form, harmony, orchestration, and other parameters. Sequencers and audio editing software offer students the ability not only to listen to pre-recorded music but also to manipulate it. Students can demonstrate their understanding of musical form by literally separating a piece of recorded music into its structural components. In this way, expositions, recapitulations, second choruses, guitar solos, all become discrete audio events, which in turn can be rearranged—resequenced—into new formal configurations. Apple's *GarageBand* has become popular among

## TECHNOLOGY INTEGRATION EXAMPLE 1

### TECHNOLOGY IN MUSIC INSTRUCTION

**TITLE:** Compose Music from Luminaries

**CONTENT AREA/TOPIC:** Music practice and composition

**GRADE LEVELS:** K–5

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making

**21ST CENTURY SKILLS:** Creativity and Innovation: Think creatively; Communication and Collaboration: Communicate clearly; ICT Literacy: Apply technology effectively

**DESCRIPTION:** *Children's Music Journey* is a collection of software that teaches music to students. The lessons feature one piano lesson from luminaries such as Beethoven and Mendelssohn at the start of each session. The composer gives students continuous and immediate feedback as they practice, and when they complete a lesson the composer encourages students to work on more exercises and explore the curriculum. As students advance, teachers may encourage them to spend time in the recording studio, where they can record and listen to their composition. In classes where the computer/MIDI keyboard ratio is high, *Children's Music Journey's* manual presents ways for teachers to complete face-to-face activities. The student assessment checklist makes tracking students' progress easy for teachers and students themselves. When needed, teachers may assign the suggested recitals to give students a chance to demonstrate their ability.

**Source:** Based on a concept by Banister, S. (2009). *Children's Music Journey. Learning and Leading with Technology*, 37(1), 14–20.

young people for mixing and playing their own music. Multimedia authoring programs like *Flash* and *Director* exemplify another type of technological tool that can be used to facilitate the understanding and exploration of musical form. *BubbleMachine*, a Flash-based program developed by Scott Lipscomb and Marc Jacoby, is available for free download to educators and allows the user to create interactive listening guides for any audio MP3 file (<http://lipscomb.umn.edu/bubblemachine/index.htm>). Also available from this same website are a variety of template files that can be used to create interactive listening guides for any composition falling into the following established musical forms: sonata form, AABA, and 12-bar blues.

Students with performance skills can record MIDI data over their favorite audio recordings using different kinds of MIDI controllers. More advanced analysis projects, such as those that might take place in an advanced placement music theory class, can now be undertaken using music software as a presentation tool. Consequently, the general music class can accomplish a great deal more than simply providing those students who are supposed to be unmusical or at least untrained with a passive listening experience.

While the preceding scenarios lend themselves best to a lab environment with multiple computers, even a single computer can provide valuable support for a general music curriculum. According to Smith (2010), creative pedagogy, free software tools, and a single computer classroom can be combined to effectively engage students in group composition and analysis of music as they learn collaboratively. Smith (2010) explains that when educational resources are limited, using a free audio recording and editing program like *Audacity* can be a powerful educational tool for collaborative work composing, performing, and recording music or manipulating elements such as pitch and tempo in order to deconstruct and analyze the dynamic elements of music as well. The integration of technology like this also provides a medium for the formative and summative assessment of students' creative products and performances, as well as their understanding of fundamental music concepts (Bauer, 2010). There are numerous open-source software options for music production that make it more and more viable in the K–12 classroom (see Open-Source Options).

### Support for Music Performance

Software like *Finale* and *Sibelius* offer all of the power and flexibility of word processing applied to music notation. In a school music program, this category of software expedites many of the tasks related to ensuring that each student has something to play, allowing the teacher (or students) to rearrange music for alternate instrumentations, transpose parts into more accessible keys for performance, and simplify difficult passages. When printed, notation documents are legible and have a professional look, eliminating the lack of clarity and potential confusion that can result from handwritten parts. And, as is the case with all computer-generated data, existing documents can be corrected and/or revised without having to reenter the music from scratch. Notation files are small in comparison to digital audio, video, and graphics files, so entire libraries (hundreds of scores, parts, and handouts) can be stored using an insignificant amount of disk space.

With notation software, teachers can create theory lessons, quizzes, and other handouts that combine notation with text and other graphics. In fact, the most recent versions of these programs often include templates or wizards to greatly facilitate the creation of such informational

# Free open source **OPTIONS** for Free Software for Art and Music Classrooms

**TYPES****FREE SOURCES**

**Free audio editing and recording software**

*Audacity*: <http://audacity.sourceforge.net>

*Power Sound Editor*: <http://www.free-sound-editor.com>

**Free music notation software**

*MuseScore*: <http://musescore.org>

*NoteFlight*: <http://www.noteflight.com>

*Canorus*: <http://www.schoolforge.net/education-software/educational-edutainment/canorus>

**Free drawing, photo editing, and graphic design software**

*Gimp* (photo editing): <http://www.gimp.org>

*Google SketchUp* (3-D modeling): <http://sketchup.google.com>

*Inkscape* (vector drawing): <http://inkscape.org>

*Sumo Paint* (online drawing and photo editing): <http://www.sumopaint.com/home>

documents and assessments. The capability of exporting sections of a musical score in a graphic format (GIF, JPG, or EPS) makes the insertion of these images into word processing documents very easy to accomplish. Even when such capabilities are not built into the notation software, screen captures of short passages can be created from the notation document and then inserted into a word processing document. Advanced notation programs also allow for maximum flexibility in generating unusual or irregular layouts.

In clarifying the roles of the sequencer and the notation program in the teaching of music performance, analysis, and composition, it is helpful to consider the hypothetical scenario of an ensemble class. To support sectional or individual practice, the teacher could enter the score of a piece into a sequencer. Once the music had been entered, the student or teacher could choose which parts needed to be heard, creating a “music-minus-one” type of accompaniment. In this way, for instance, the clarinet section could rehearse to a sequence consisting of the entire ensemble minus the clarinets. Or the second clarinet player could practice sectional passages by selecting only the clarinet parts for playback, but muting the second clarinet part. Meanwhile, the notation program could be used to edit any parts that need to be revised in order to better match the performance level of the students. These techniques have been demonstrated effectively by Rudolph and Peters (1996), and their effect on improving students’ understanding of musical relationships

and performance skills in the secondary music classroom has been confirmed by research conducted by Carlisle (2011).

During the past decade, the piano lab has given way to the electronic keyboard lab, where students can develop much more than keyboard skills. Demski (2010) describes how electronic keyboard labs can be used to help students learn about music theory as well as fundamental music elements such as melody, rhythm, and harmony. Keyboard labs can now be networked with devices that allow the teacher to communicate with individual students or groups of students by means of a microphone and headphones. This allows instructional guidance as students are afforded the freedom to explore, experiment with, and compose music. Developing composition skills also provides an outlet for creative expression (Demski, 2010). Southcott and Crawford (2011) advocate for pedagogical strategies that encourage using music technology as more than just a technical tool. Also see how to help all students have access to this tool in the Adapting for Special Needs feature.

## Support for Self-Paced Learning and Practice

Most CD-ROM–based programs can accommodate both self-paced learning and activities more closely directed and monitored by the teacher. *Practica Musica*, for example, can be used as a tutorial in music fundamentals with little or no

input from the teacher. It can also serve as a drill program when a student needs help with a particular topic related to ear training or music theory. Teachers need to consider multiple integration strategies when evaluating and using instructional software. While interactivity and multimedia make instructional software a potentially more powerful teaching aid than an inert, linear textbook, these programs cannot replace a teacher's careful supervision. In the end, the responsibility for effective teaching—with or without technology—rests with the teacher.

Almost all music instructional software packages either have a designated drill component or can be utilized as such; they are probably the easiest programs to install and to learn. Many have the capability of maintaining assessment information and other important data for multiple students on the same computer, accessible only to the instructor through use of a password-protected account. Companies generally provide online demos or trial downloads of these programs so that teachers can sample them before they buy.

## Support for Teaching Music History

Of the nine national standards for music education, the only one that refers specifically to music history is the last one: "Understanding music in relation to history and culture." General music teachers have long sought to foster a deep understanding of musical works by situating them in their

social and historical context. This is an excellent way to introduce young students to the practice of research, while offering more mature students unlimited opportunities for independent projects. The Internet is rapidly becoming the most powerful research tool available to students and teachers at all levels of education. Students and teachers can access card catalogs, electronic books, online journals, archived and current newspaper articles, audio and MIDI files, video clips, databases of thousands of out-of-print books, and discussion groups on almost any topic imaginable. Productive educational use of the Internet is limited only by the user and, to some extent, the connection speed and processing power of the computer. The effective use of such powerful tools requires clear instruction, guidance, and supervision by the teacher.

Building a website can be a perfect culminating activity for a general music class. Students can do much of the planning in groups—even offline, if computer access is limited. Within each group, students can assign themselves areas of the site according to individual strengths and literacies: A student who can't read music may be proficient with a web page authoring tool; some students can search the Internet for relevant graphics while others look for text or sound. Videos and DVDs continue to be a source of valuable historical reference material, many in the form of informative documentaries. Use of DVDs is highly advantageous for the user since they provide random access to content through the designation of chapter markers. Excerpts from these



## ADAPTING FOR SPECIAL NEEDS

### Music and the Arts

**S**tudents with disabilities need to participate in music and art just as other students do. In some cases, some accommodations are necessary to ensure opportunities for access and engagement. The resources below describe some resources that may be useful.

#### Music

- » Assistive Technology in Education/Music: [http://en.wikibooks.org/wiki/Assistive\\_Technology\\_in\\_Education/Music](http://en.wikibooks.org/wiki/Assistive_Technology_in_Education/Music)—An overview of strategies and tools for using assistive technology to provide access to music for students with disabilities.
- » Meet Karly W. and Learn About Her Successful Use of Assistive Technology: <http://www.fctd.info/feature.php?id=33>—A profile from the Family Center on Technology and Disability of a student and the efforts of

her teachers to help her learn to use assistive technology to enhance her access and engagement with music.

#### The Arts

- » Art for Children and Adults with Disabilities: <http://www.kinderart.com/special>—Resources and art activity ideas for children and adults.
- » Artwork: <http://www.washington.edu/doi/Faculty/Strategies/Academic/Artwork>—Suggestions for teachers and college instructors on how to make art more accessible for students with disabilities.
- » Very Special Arts: <http://www.vsarts.org>—An international organization devoted to promoting participation in the arts by individuals with disabilities.

*Contributed by Dave Eadyburn*

media can be captured on a computer's hard drive and incorporated into a student- or teacher-authored web page or software presentation as long as care is taken to clearly understand and follow existing copyright laws. With the advent of digital music files, the understanding of the copyright law as it relates to digital media is a very important aspect of a student's education. Finished projects can be viewed locally on a single computer, burned to a CD for multiple computers, posted on a school intranet, or uploaded to an Internet site so that parents or other students around the world can see it, link to it, and perhaps even contribute their own material.

Finally, compelling music classes have the potential to be highly effective recruiting tools. Students who initially feel out of place in their school's traditional music program dominated by instrumental and/or choral ensembles may find an exciting and challenging alternative role for themselves by enrolling in a technology-enhanced general music class or a new music class focusing on digital music creation and audio engineering. Often, it is access to music technology that attracts these students, who typically constitute 80% to 85% of the secondary school population, and provokes in them a new interest in music (Olson, 2010). In addition to gaining the attention of nontraditional music students, Olson (2010) maintains that technology holds particular promise for music education in the areas of collaborative as well as interdisciplinary learning.

## Support for Interdisciplinary Strategies

Beyond the opportunities for interdisciplinary study that will inevitably present themselves in a general music class, student-produced music and research can enhance a variety of other aspects of school life. Multimedia-based research projects in the humanities can easily include music that underscores a presentation or that is itself the object of study. A sequencer can facilitate the work of student composers who want to supply music for dance projects or video footage of athletic events. The close relationship between music and physics calls for projects that examine the science of sound by exploring elements such as vibration, pitch, and amplification. Identifying the existence of shared fundamental concepts across disciplines (e.g., ratios represented in math as fractions and in music as note durations) opens the door to a new world of learning potential within which multiple representations of these basic concepts and their connections are used to deepen student understanding (An, Ma, & Capraro, 2011). It follows that in music—as in other disciplines such as science or mathematics—creativity, innovation, and knowledge production are inextricably linked (Ghassib, 2010).

## ISSUES AND PROBLEMS IN ART INSTRUCTION

Like music instruction, art instruction faces many classroom challenges that intersect with technology integration. This section addresses these important issues.

### Funding for Art Instruction

As a result of lean economic times and the ever-increasing emphasis on accountability in mathematics and reading as reflected in standardized testing related to the No Child Left Behind Act, funding for arts education is at an all-time low. Teachers and school administrators must increasingly find ways to stretch funds available for arts education. In light of this reality, funding for technology in art is especially difficult; updating technology resources and buying electronic supplies present continuing problems. For example, production of graphics is a popular art activity, but the cost of expensive ink for printers and specialized paper supplies quickly depletes an annual budget. Teachers are forced to take measures such as password-protecting printers and putting software print controls in place to limit the number of pages a student may print for free.

### Ethical Issues Associated with the Use of Images and Other Materials

Since it is becoming easy to use images from the Internet and other sources, it is increasingly important to teach students that they must cite sources and request permission to use information, images, or other sourced materials. When students are carrying out research or creating artwork on the computers for websites or graphic design or other art projects, it is important to instruct them about issues of appropriation and repurposing of images and how this use intersects with plagiarism. Discussions should take place about issues of copyright law and what constitutes infringement. Perhaps a short assignment early in the term could require students to identify the specific issues and how they feel about copying someone else's work, whether text, image, or sound.

### Accessing Images Used in Art Instruction

If schools use filtering software on computers to protect students from unsavory materials (e.g., pornography), many great works of art are also likely to be filtered out, unless the filter is carefully constructed. Care should be taken to allow these important artworks to be visible and accessible

to students. The works of lesser known, more contemporary artists can sometimes blur the line between what is generally considered to be art and what is not. In photography, the nude figure has been a common subject. Some of the great artists have used the nude as metaphor for beauty, nature, and life. Limiting access by allowing only the names of the most famous artists to pass through a filter will not solve the problem. Strategies must be designed for allowing complete access to images of artworks for students to use. If all else fails, teachers must make sure the school library has a good collection of art and art history books. Also, many museums have images from their collections available on CD or DVD for purchase.

## The Challenge of Meeting Standards in Arts Instruction

Despite the limited funding for the arts and arts education, a group of professional organizations joined with the Consortium of National Arts Education Associations to promote a vision of K–12 arts education as described in the National Standards for Arts Education (<http://artsedge.kennedy-center.org/educators/standards.aspx>). The standards suggest that students know and be able to do the following by the time they have completed secondary school:

- » Be able to communicate at a basic level in the four arts disciplines—dance, music, theatre, and the visual arts. This includes knowledge and skills in the use of the basic vocabularies, materials, tools, techniques, and intellectual methods of each arts discipline.
- » Be able to communicate proficiently in at least one art form, including the ability to define and solve artistic problems with insight, reason, and technical proficiency.
- » Be able to develop and present basic analyses of works of art from structural, historical, and cultural perspectives, and from combinations of those perspectives. This includes the ability to understand and evaluate work in the various arts disciplines.
- » Have an informed acquaintance with exemplary works of art from a variety of cultures and historical periods, and a basic understanding of historical development in the arts disciplines, across the arts as a whole and within cultures.
- » Be able to relate various types of arts knowledge and skills within and across the arts disciplines. This includes mixing and matching competencies and understandings in art making, history and culture, and analysis in any arts-related project.

Schools are challenged to find ways of meeting these standards in an educational climate in which the role of the arts is often not a priority.

## TECHNOLOGY INTEGRATION STRATEGIES FOR ART INSTRUCTION

As with music instruction, technology resources in art instruction support a variety of classroom strategies—from simple demonstrations of materials to student production techniques. Strategies include accessing art examples for classroom use, using teaching examples and materials, producing and manipulating digitized images, supporting graphic design and 3-D modeling, supporting desktop publishing with graphics, virtual field trips to art museums, creating movies as an art form, using **computerized kilns**, and sharing students' creative and research works. These are summarized in Table 3.

### Accessing Art Examples for Classroom Use

Internet sites and DVD collections are rich sources of artwork that students can use as illustrations of artists' work and as models for their own work. Teachers can generate a set of sites to bookmark for regular use in classes (see Figure 1). They can also get students involved in these searches. For example, they might give students an assignment that asks them to find sources for paintings that use still life as subject matter, that use the technique of chiaroscuro, or that are 15th century Florentine. As a result of students actively looking and sharing, more learning will take place. Other example activities include:

- » Have students use the school library to find specific works of art, and then challenge them to locate on the Internet other examples of the artist's work or work from the same period.
- » To teach about the work of contemporary artists, have students look at galleries and exhibitions online to see the new work.
- » For instructional reinforcement, use DVD collections on art techniques.
- » Create a digital library to use for slide shows and presentations. Assign students who are traveling during the school year or during the summer to visit galleries and museums and bring back pamphlets, postcards, or examples of artwork they see. Scan the examples to create images for the classroom digital library.
- » Obtain and use resources such as the Masters of Photography CD.



**TABLE 3** Summary of Technology Integration Strategies for Art

Technology Integration Strategies	Benefits	Sample Resources and Activities
Accessing art examples for classroom use	<ul style="list-style-type: none"> <li>Internet and CD collections provide ready access to works of art to use as samples, illustrations, and models.</li> </ul>	<ul style="list-style-type: none"> <li>Masters of Photography CD <a href="http://www.masters-of-photography.com">http://www.masters-of-photography.com</a></li> <li>World Wide Arts resources art history section <a href="http://www.ar.com/artisu">http://www.ar.com/artisu</a></li> <li>Kinder Art's Multicultural Art resources <a href="http://www.kinderart.com/multic">http://www.kinderart.com/multic</a></li> </ul>
Using teaching examples and materials	<ul style="list-style-type: none"> <li>Multimedia slide lectures are easier to use than slides and allow quick, random access to examples, illustrations.</li> <li>Teacher-created websites can provide easy-to-access exercises in color theory, design theory, and photography techniques.</li> </ul>	<ul style="list-style-type: none"> <li><i>Powerpoint, HyperStudio, Apple's Keynote</i></li> <li>Teacher-created websites, e.g., <a href="http://www.nku.edu/~houghton/docent">http://www.nku.edu/~houghton/docent</a></li> </ul>
Producing and manipulating digitized images	<ul style="list-style-type: none"> <li>Offers an easy, flexible system for creating images.</li> <li>Lets novice artists create high-quality products.</li> <li>Lets novice artists scan found objects to use in compositions.</li> </ul>	<ul style="list-style-type: none"> <li>Camcorders, VCRs, digital cameras, scanners</li> <li>Digitizing software, e.g., <i>FotoFinish</i> <a href="http://www.fotofinish.com">http://www.fotofinish.com</a></li> <li>Paint programs, e.g., Riverdeep's <i>Kidpix</i>, Adobe's <i>Photoshop Elements</i></li> </ul>
Supporting graphic design and 3-D modeling	<ul style="list-style-type: none"> <li>Makes possible graphic techniques that can be done only on the computer with this software.</li> <li>Offers many opportunities for artistic expression.</li> <li>Demonstrates how easily images can be altered, thus fostering visual literacy skills.</li> </ul>	<ul style="list-style-type: none"> <li>Image manipulation software, e.g., Adobe <i>Photoshop</i> <a href="http://www.adobe.com">http://www.adobe.com</a></li> <li>Morphing software, e.g., <i>Morpheus</i> <a href="http://www.morpheussoftware.net">http://www.morpheussoftware.net</a></li> <li>3-D modeling software, e.g., <i>Ulead COOL 31</i> <a href="http://www.ulead.com">http://www.ulead.com</a></li> </ul>
Supporting desktop publishing with graphics	<ul style="list-style-type: none"> <li>Lets students illustrate their brochures, newsletters, and other documents with high-quality graphics.</li> </ul>	<ul style="list-style-type: none"> <li>Adobe <i>Photoshop</i> <a href="http://www.adobe.com">http://www.adobe.com</a></li> </ul>
Virtual field trips to art museums	<ul style="list-style-type: none"> <li>Allows students to see models and examples of artworks not locally available.</li> <li>Makes possible multicultural "field trips" to gather examples of art and music from around the world.</li> </ul>	<ul style="list-style-type: none"> <li>Virtual Tour of the Louvre Museum, Paris <a href="http://www.louvre.fr/anglais/visite/visf.htm">http://www.louvre.fr/anglais/visite/visf.htm</a></li> <li>Art Institute of Chicago <a href="http://www.artic.edu">http://www.artic.edu</a></li> <li>Museum of Modern Art <a href="http://www.moma.org">http://www.moma.org</a></li> <li>Metropolitan Museum of Art <a href="http://www.metmuseum.org">http://www.metmuseum.org</a></li> <li>Smithsonian museums <a href="http://www.si.edu">http://www.si.edu</a></li> <li>National Gallery of Art <a href="http://www.nga.gov">http://www.nga.gov</a></li> </ul>
Creating movies as an art form	<ul style="list-style-type: none"> <li>Students can produce their own creative works for research, reports, assignments, and entertainment.</li> </ul>	<ul style="list-style-type: none"> <li>Apple <i>iMovie</i> and <i>GarageBand</i> <a href="http://www.apple.com">http://www.apple.com</a></li> <li>ArcSoft's <i>Videolmpression</i> <a href="http://www.arcsoft.com">http://www.arcsoft.com</a></li> <li>Microsoft's <i>Movie Maker</i> <a href="http://microsoft.com">http://microsoft.com</a></li> </ul>

**FIGURE 1 Recommended Websites for Museums and Virtual Field Trips**

- Virtual Tour of the Louvre Museum, Paris ( <http://www.louvre.fr/llv/commun/home.jsp>)
- Art Institute of Chicago ( <http://www.artic.edu>)
- Museum of Modern Art ( <http://www.moma.org>)
- Metropolitan Museum of Art ( <http://www.metmuseum.org>)
- Smithsonian Museums ( <http://www.si.edu>)
- National Gallery of Art ( <http://www.nga.gov>)
- Whitney Museum of American Art ( <http://www.whitney.org>)
- Andy Warhol Museum ( <http://www.warhol.org/default.aspx>)
- Art Museum Image Consortium ( <http://www.amico.org>)
- Tour of Florence Cathedral ( [http://www.panoramicearth.com/5380/Florence/Florence\\_Cathedral](http://www.panoramicearth.com/5380/Florence/Florence_Cathedral))
- Photography Exhibition of the work of Douglas Prince ( <http://www.nku.edu/photo/prince/index.html>)
- Great Artists: DaVinci to Picasso ( <http://www.theartgallery.com.au/ArtEducation/greatartists>)
- Fine Art History Quick Reference ( <http://www.theartgallery.com.au/ArtEducation/greatartists>)
- Masters of Photography ( <http://www.masters-of-photography.com>)
- Photography of Henri Cartier-Bresson from NPR ( [http://www.npr.org/display\\_pages/features/feature\\_1318621.html](http://www.npr.org/display_pages/features/feature_1318621.html))
- International Sculpture Center ( <http://www.sculpture.org>)
- Architect Frank Lloyd Wright Foundation ( <http://www.franklloydwright.org>)
- Architect Zaha Hadid ( <http://www.zaha-hadid.com>)
- Great Buildings Online ( <http://www.GreatBuildings.com/gbc.html>)
- Non-Western art listings at Penn State Library ( <http://www.libraries.psu.edu/artshumanities/art/nonwestern.html>)
- Non-Western art links ( [http://www.bc.edu/bc\\_org/avp/cas/fnart/links/non\\_Western.html](http://www.bc.edu/bc_org/avp/cas/fnart/links/non_Western.html))
- Non-Western art links on The Educator, online magazine for the professional in education ( <http://www.the-educator.co.uk/mainsite/links/art/nonwes.htm>)
- Science, Art, and Technology course from Art Institute of Chicago for science teachers ( <http://www.artic.edu/aic/students/sciarttech>)

**Using Teaching Examples and Materials**

Computers can be used by teachers to create *PowerPoint* slide lectures and to bring in images either by scanning or photographing with digital cameras. Also, faculty who are web savvy can create interactive websites to help students learn color theory, design theory, and photography techniques.

**Producing and Manipulating Digitized Images**

The most common type of hardware resource in art instruction is image digitizing equipment. Graphic scanners are computer peripherals that transfer print materials into digital images on a computer. A scanner can transfer images, photographs, line drawings, or text into graphics files in a cost-effective and efficient manner. An artist can also capture an image from a video source (camcorder or VCR) using digitizing software like *iMovie*, *Final Cut*, or *Premiere*. Finally, a digital camera allows direct transfer of images

to the computer hard drive. This equipment provides the user with a flexible system for capturing and manipulating digital images using computer software like *Photoshop*. This is a good example of using technology to foster creativity. Indeed, the ability to digitize still images and video has opened up a whole new genre of art.

A wide variety of software is available to teachers and students who are interested in producing computer art. Simple paint programs (*Paintbrush*, *KidPix*) are available for very young students; in fact, teachers often use these types of programs when first introducing students to the computer. Integrated software and hypermedia authoring programs (*Flash* or *Director*) always include fairly sophisticated draw or paint tools—good intermediate tools for the developing computer artist. High-level programs (*Photoshop*) suitable to the advanced artist would be used primarily at the high school level. One way a student might use paint or draw software would be to design the layout for a hypermedia project. Using these tools, a student who does not possess highly developed artistic techniques can produce a very attractive design. There are numerous opportunities for

students to utilize existing photos and paintings on the web while also developing their own paintings (see Technology Integration Example 2) using desktop software programs or even mobile apps (see Mobile Apps for Education).

## Supporting Graphic Design and 3-D Modeling

Art educators can choose from among a number of software options to let students explore graphic design. A range of animation programs is available, from simple cell-type animation to more advanced programs that offer features

like **tweening** or **morphing**, graphic techniques that can be done only with computer software. Other programs are specifically geared toward cartoon production and allow artists to add music and sound.

An art studio would not be complete without an image manipulation program like Adobe *Photoshop*, which enables students to edit clip art or digital photos. High-end programs provide hundreds of options and special effects for altering images. Morphing software enables the user to transform images smoothly from one shape or image to another. This technique offers tremendous potential for artistic expression and, by demonstrating how easily images can be altered, helps foster the development of visual literacy skills.

Finally, as Davenport and Gunn (2009) and Bryant (2010) contend, students can use 3-D, modeling, and animation software to communicate ideas visually through computer-generated models, animation, and imagery. Davenport and Gunn (2009) describe a powerful example of the use of these tools in a high school media literacy program they developed to serve indigenous youth from under-represented populations throughout remote areas of rural Mexico. Students used digital images and video cameras, as well as 3-D and animation software, to visually communicate images and stories about their cultures and traditions. The integration of technology as a medium to design and create not only aided in the opportunity for these students to explore their own identity, but also aided in their empowerment by giving them a voice to share their unique backgrounds and experiences through artistic and cultural expression. Bryant (2010) confirms that such transformative learning experiences may also occur in traditional art classrooms as students' creativity, engagement, and collaborative problem-solving skills are fostered by the use of 3-D animation and visual imagery to create captivating artwork that holds personal meaning.

### TECHNOLOGY INTEGRATION EXAMPLE 2

#### TECHNOLOGY IN ART INSTRUCTION

**TITLE:** Organize and Create Music

**CONTENT AREA/TOPIC:** Music history and composition

**GRADE LEVELS:** 2–8

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 3—Research and Information Fluency

**21ST CENTURY SKILLS:** Creativity and Innovation: Think creatively; Communication and Collaboration: Communicate clearly; ICT Literacy: Apply technology effectively

**DESCRIPTION:** *Groovy Music City* is software designed to teach young children about music composition and music instruments. With the help of this software, students may choose to explore musical instruments and learn their names or listen to their sounds by interacting with them. When needed, teachers ask students to match music instruments with their corresponding sounds. Students perform this exercise by dragging and dropping the sounds to the correct instrument. In addition to sounds, *Groovy Music City* presents etymological definitions of technical words used in the program, such as *piano* and *forte*, and the suffix *-issimo*, which makes *pianissimo* and *fortissimo*. As students progress and learn about various types of musical instruments the teacher can ask them to categorize music instruments by dragging and dropping each one of them to their instrument families. As students' knowledge grows, they may compose music by dragging and dropping music tracks and loops or they may listen to duets and identify which instrument family each one belongs to. It is also possible for students to share their composition with the teacher, their friends, or their peers via the Internet.

**Source:** Based on concepts from Banister's 2010 reviewing of *Groovy Music City* in *Learning and Leading with Technology*.

## Supporting Desktop Publishing with Graphics

Many schools look to their own graphic arts programs for the creation of brochures and newsletters as part of student learning activities. Because students gain valuable experience through creating and producing these publications, the activities can be considered a kind of internship to prepare for actual jobs as graphic artists for newspapers or other companies.



## Virtual Field Trips to Art Museums

Many museums around the world have sites that allow a virtual tour through the museum. Although clearly this is



# MOBILE APPS FOR EDUCATION

## MUSIC AND ART EDUCATION

App Name	Description	Device
<p><i>Drawing Pad</i></p> 	<p>An award-winning, full featured mobile art studio, <i>Drawing Pad</i> offers an incredible amount of fun and creativity as a stand alone app, but the developers have included the ability for parents to extend the use of this app by offering in-app coloring books. Children can create their own art using "actual-sized" photo-realistic crayons, markers, paintbrushes, colored pencils, stickers, roller pens, and more. They can save their artwork to the Drawing Pad Album and reload it later to keep working on it.</p>	<p>Android &amp; iPad</p>
<p><i>Discover Musical Instruments</i></p> 	<p>This educational game offers an extensive collection of 44 high quality musical instrument pictures and sound clips to give your kids a rich and fun learning experience about the wonderful musical world. It will also help them discover their sense of rhythm! This app can be easily used by children as young as 6 months old, when they express a desire to touch everything! The combination of visual and auditory contents makes this application ideal for learning musical instruments vocabulary.</p>	<p>iPad, iPhone &amp; iPod Touch</p>

*Source:* Images reprinted by permission of Murtha Design Inc. and Mathieu Brassard.

not the same as viewing the works in person, virtual tours do offer a way for students to explore and expand their knowledge base. However, with the development of new stereo-enhanced 3-D imagery, many museums are exploring ways in which this technology can be used to provide virtual visitors with a more compelling, visceral experience by creating illusions that make the tour, as well as museum artifacts, seem even more realistic (Steinbach, 2011). To support classroom learning, some museum sites even make their server available for students to post their own creations and to learn to create art using a certain medium like papier maché, batik, or origami. These sites also can be the basis for multicultural "field trips" to gather examples of art and music from around the world (Risinger, 2010). When using the Internet for arts instruction, it is important to remember that the images are reproductions; students will need to be made aware of the idea of scale and be reminded that they need to keep in mind the limitations of digital imagery. Check out the Hot Topic Debate feature for this chapter related to virtual field trips. Can a virtual tour of a museum supplant the actual museum field trip?

### Creating Movies as an Art Form

Students can now make short digital movies with software that often comes with the computer. For example, Macintosh computers come with *iMovie*, and Windows computers come

with *Movie Maker*, both of which allow students to produce their own creative works using images, digital video, and sound for the purpose of reports, assignments, and entertainment. These inexpensive-to-create movies can be shared across platforms by saving them in QuickTime or Flash Video format. Not too long ago, creating video projects was expensive and difficult, but with the new generation of video editing software, it is affordable and relatively easy to accomplish.

### Using Computerized Kilns

Art teachers who work in fired pottery media can use computerized electric kilns to save student time and assure better-quality products. Computerized kilns automatically set required temperatures, monitor lengths of time, and begin the process of cooling down and shutting off. Without the computer, teachers and students must keep a careful eye on the kiln and check the temperature by using cone indicators viewed through a peephole in the door of the kiln. The process of firing a kiln can take days, depending on the type and size of the kiln and its load, so this represents a considerable time savings.

### Sharing Students' Creative and Research Works

Through electronic publishing, videos, and presentation software, students can share their art creations with others

## CAN A VIRTUAL TOUR OF A MUSEUM SUPPLANT THE ACTUAL MUSEUM FIELD TRIP?

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.

Many museum websites offer virtual tours of their exhibits, including notable museums such as the Louvre (<http://www.louvre.fr/llv/commun/home.jsp>) and the National Museum of Natural History (<http://www.mnh.si.edu/exhibits/virtual.html>). These tours typically include text, images, video, and interactive elements. Do online museum tours have a place in art classrooms? Can an online tour of a museum supplant an actual museum field trip? What evidence can you cite that helps define an appropriate and helpful role that supports both instructors and students?

(see Figure 2). Portfolios have long been a way for art students to demonstrate their achievements and abilities, and electronic portfolios are a natural extension of this strategy. Students can create *PowerPoint* presentations, videos, electronic books, blogs, and websites to show their research and

creative work. Artists' books can be created and printed using desktop publishing and color inkjet printers.

**FIGURE 2** Art Education 2.0: Collaboration Opportunities for Art Educators



Source: Craig Roland, 2011. Reprinted by permission.

## TECH-PACK NEEDS AND CHALLENGES IN ART AND MUSIC EDUCATION

Teachers who have sufficient art and music education Tech-PACK are not only well-acquainted with the content and standards of the topics they must teach and the pedagogical strategies for teaching this content, they also must think automatically of the technologies that will help them carry out effective lessons to teach the content. In art and music education, a teacher is incorporating Tech-PACK when he or she thinks about the pedagogy and technology that can be used to foster the skills necessary for art and music creation. For example, when teaching students the basics of music notation, a teacher using the Tech-PACK perspective thinks about the existing technologies that can communicate the fundamental concepts and how his or her students can learn these concepts in a way that would not be possible without the technology. Thus, a teacher thinks about how he or she can use software products like *MuseScore* (<http://musescore.org>) or *NoteFlight* (<http://www.note-flight.com>) to show, in real time, the correspondence between the notes of a song represented visually and their corresponding pitch.

## Art and Music Content Knowledge

**Art content knowledge.** The field of art presents a unique array of special problems related to teachers' content knowledge. First, art is a broad content area that encompasses many mediums, including digital ones. Many teachers lack sufficient preparation with the technologies necessary for the production of digital art. The inclusion of digital media in the domain of art education also requires art educators to be especially aware of the ever-changing digital media production landscape.

**Music content knowledge.** The field of music also presents a unique array of special problems related to teachers' content knowledge. Like art, music is a broad content area that includes music performance, production, history, and theory. Music content knowledge also includes knowledge of the technology tools that aid in the production of music as well as the communication of music concepts and theory.

## Art and Music Pedagogical Knowledge

**Art pedagogical knowledge.** Pedagogical knowledge is often specific to the content area. Each of the art content areas presents particular pedagogical challenges. For example, art production requires strategies that help students learn better technique, while art history and appreciation requires pedagogical strategies that foster the ability to recognize the underlying components of a particular piece of artwork and how they interact. All pedagogical strategies must be supported and facilitated with technologies that are appropriate for each.

**Music content knowledge.** Like art, music requires different pedagogical strategies based on whether the content at hand relates to production or an understanding of underlying elements. For example, students can use audio editing and production software such as *GarageBand* (Apple) to freely experiment with various sounds and structures while creating compositions. Notation software can be used to not only create compositions but to teach students the fundamentals of music theory. In either case, an understanding of what technology supports a given pedagogical strategy is imperative.

## Art and Music Technology Knowledge

The use of technology within art and music education has the potential to transform the learners' experiences.

Teachers need to acquire technological knowledge to allow students to learn with and from technology. Teachers need to know about the technology and how to use the technology that affords learning specific concepts and strategies within their classroom. Within any content area, the technology knowledge is many times content and surely pedagogically-specific.

Teachers also need to "know what they don't know" regarding technology in their content area. Research is required to acquire this knowledge along with time and professional development to understand the procedural knowledge of using the technology.

## Strategies for Improving Tech-PACK in Art and Music

Strategies for improving Tech-PACK vary a great deal, and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

- » Do I have the art and music content knowledge needed to assist my students in meeting the standards within my classroom?

If a teacher does not have the necessary content knowledge, they may consider taking additional art or music education courses at a university, attending local workshops, attending professional conferences, and/or working with a mentor who can assist in the knowledge development.

- » Do I have the art and music technological knowledge needed to teach the art and music content within my classroom?

One of the struggles with technological knowledge is that there are so many options to be aware of, and technology learning take a great deal of time. Teachers need to be motivated to find these technologies, have the confidence to learn them, and then ultimately, use them in their classroom. Learning and teaching with technology can be fun and rewarding, but it does take time. Teachers need to take this time and schools need to provide the professional development opportunities.

- » Do I have the art and music pedagogical knowledge needed to teach the art and music content within my classroom?

Teachers need to be able to take their content and technology knowledge, meld them together, and be able to draw from multiple pedagogical models based on their classroom context to teach their students. For teachers to improve their pedagogical knowledge, they need to be given the opportunity to work with a mentor who has the content and technology knowledge, attend professional development opportunities, and be given the “license to fail.” What is meant by a license to fail is that administrators need to allow teachers to try new technological and pedagogical approaches, even when it is not always successful. If teachers

are not given the opportunity to try new and innovative approaches, progress and advancement will not occur.

As part of the end of chapter materials, we are asking you to deconstruct a teacher’s Tech-PACK based on what you know of their knowledge and what must be learned to teach art and music effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on what you would want in your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone.



## SUMMARY

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

### 1. A Rationale for Teaching Arts in the Information Age—

Four parts of the justification for including art and music in school curriculum are: expanded modes of expression; literacies for an Information Age; creative approaches to modern problems; and arts as aesthetic balance.

**2. Issues and Problems in Music Instruction—**These include issues such as redefining music literacy; training teachers to meet music standards; the intersection of popular music, technology, and music education; and the music director as small business administrator.

**3. Integration Strategies for Music Education—**These strategies are described for integrating technology into support for music composition and production; support for music performance; support for self-paced learning and practice; support for teaching music history; and support for interdisciplinary strategies.

**4. Issues and Problems in Art Instruction—**These include issues such as funding for art education; ethical issues with

using images; accessing images used in art education; and the challenge of meeting standards in arts education.

**5. Integration Strategies for Art Instruction—**These strategies are described for integrating technology into accessing art examples for classroom use; using teaching examples and materials; producing and manipulating digitized images; supporting graphic design and 3-D modeling; supporting desktop publishing with graphics; virtual field trips to art museums; creating movies as an art form; using computerized kilns; sharing students’ creative and research works; and web-enrichment activities.

**6. Tech-PACK Needs and Challenges in Music and Art Instruction—**Teachers need to be able to evaluate their technological, pedagogical, and content knowledge and know how they can improve their knowledge domains to become the most effective teacher as possible.



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** Mr. Orson, a music performance teacher, has been talking to his friend and colleague, Mr. Niesson, who is a music teacher in Dublin, Ireland. Mr. Orson and Mr. Niesson would like to have their students work together on creating new musical pieces based on a series of Irish folk tunes that Mr. Niesson has collected in the rural areas near the city. Mr. Niesson would send MP3 files of the tunes, and the students would play them and work on variations based on them. However, the teachers and students need a way to make both the music production tasks and communicating their products faster and easier. What technology-based strategies could the teachers use to address these needs? What would be the relative advantage of using these strategies? What would be a good way to display their products, once they are created?

**2.** Mr. Daniel, the school's music teacher, is interested in collaborating on the development of an interdisciplinary project with Ms. Merrill, the history teacher. They plan to have Ms. Merrill's students research the backgrounds of the musical composers of the Romantic period, listen to some of their works, and locate information on the events of the times that helped shape their perspectives and, consequently, the music they created. At the same time, Mr. Daniel's students will be researching and

practicing the musical works of the composers of the Romantic period. When the students from both classes have finished their research, they will be paired together to create a blog that showcases their final products using media such as podcasts, photos, and videos. What technology-based strategy could the teachers use to carry out such a project? What would be the relative advantage of using this strategy? If they wanted to have Ms. Merrill's students work in small groups, how would they implement this in the class?

**3.** Students in Dr. Hadley's music appreciation class are preparing for their end-of-semester recitals. There is a variety of musical pieces to be performed, and Dr. Hadley plans to accompany each student during his or her recital. He wants students to be able to practice individually with accompaniment, but he did not have time to accompany each of them as they practiced. What technology-based tool could Dr. Hadley use to address this need? What would be the relative advantage of using this strategy rather than allowing students to practice without accompaniment? If Dr. Hadley has 30 music students and only eight music stations, what strategy could he use to allow each student to practice individually?



# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:

- » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
    - » What are the objectives of the lesson plan?
    - » How will you assess your students' accomplishment of the objectives?
    - » What integration strategies are used in this lesson plan?
    - » How would you prepare the learning environment?
  - Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
  - Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
  - Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Ms. Hernandez is a new art teacher in a large urban district. She has only been teaching for two years and has been asked to teach a new course entitled "Media and Literacy Arts." She has the entire summer to prepare for this course, but is really at a loss where to start. The private liberal arts college she attended focused a great deal on art history and not on production or post-modernism.*

- Deconstruct Ms. Hernandez's Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn.

## 5. WHAT'S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the "What must be learned" column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



**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.

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# TEACHING AND LEARNING WITH TECHNOLOGY IN PHYSICAL EDUCATION AND HEALTH EDUCATION

# TEACHING AND LEARNING WITH TECHNOLOGY IN PHYSICAL EDUCATION AND HEALTH EDUCATION

An early 15th century drawing by Leonardo da Vinci depicted a device that used gears and a pendulum that moved in synchronization with the wearer as he or she walked. This is believed to be the early origins of today's physical activity monitoring devices (which) have vastly expanded on da Vinci's ancient concept. . . . These new and innovative gadgets are becoming standard components in today's physical education programs.

Derrick Mears, "Physical Activity Monitoring: Gadgets and Uses," 2010



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## o u t c o m e s

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

1. Recognize the implications for technology integration of each current issue faced by teachers of physical education and health education.
2. Create key strategies for integrating technology into physical education and health education criteria.
3. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to physical education and health education.

## key terms

accelerometers  
blood pressure device  
body composition analyzer

exergaming  
heart rate monitors  
nutritional analysis program

pedometer  
spirometer  
vodcasting



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## TECHNOLOGY INTEGRATION IN ACTION: PERSONAL FITNESS PLANS YOU CAN LIVE WITH

GRADE LEVELS: 9–12 • CONTENT AREA/TOPIC: Biology, health, physical education, technology •  
LENGTH OF TIME: Three weeks

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

Mr. Martinez, a high school physical education/health teacher, is concerned that not all students are choosing to take health or physical education courses and that there is a national trend toward low exercise levels and poor eating habits among teenagers. He talks to the biology teacher and the technology education (TE) teacher about a project the three of them could do on eating habits and exercise that would meet requirements for courses in physical education/health, biology, and technology. They agree that the project would have more impact for current and future students if it could be presented in the form of videos. That way, it could be more easily presented to many students, it would be in a visually compelling format, and it could serve as a resource for future classes.

The teachers decide to write descriptions of various “example teenagers” and to have their students work in pairs and small groups to design health and fitness plans appropriate for each example. The plans the students develop will relate to human

growth and development concepts they are covering in biology, and the video design will address skills required in the technology education class. Mr. Martinez shows several simulations that the teachers agree will help make concepts about the need for fitness more visual and compelling to students. He plans to demonstrate **heart rate monitors**, devices that track the heart rate of the individuals wearing them, to show students how diet and exercise affect heart rate and other physical characteristics. Then he will show students how to document and track this information on a spreadsheet.

#### Step 2: Assess Tech-PACK.

Mr. Martinez had good experience with various technologies that could be used in the physical education/health classroom. He had also taught the same course for over 15 years and had strong content knowledge. Though the technology teacher was not well-versed in health or biology, he knew the technologies well. The biology teacher had been teaching for many years and had strong content knowledge, but he was a newcomer to most technologies. The three teachers felt that their different backgrounds would fit well together, and that their collaboration would make the project successful.



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## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

The teachers decided on three outcomes and assessments:

- » **Outcome:** Video production/group work. **Objective:** Students will demonstrate video production skills and group work skills by achieving at least an 85% rubric score on the videos they produce. **Assessment:** Rubric to evaluate videos and cooperative work skills.
- » **Outcome:** Knowledge of human anatomy/physiology, nutrition, and body system functions. **Objective:** All students will demonstrate knowledge of human anatomy/physiology, nutrition, and body systems by responding correctly to at least 90% of questions about these systems. **Assessment:** List of questions requesting example images and written descriptions as responses.

- » **Outcome:** Feasible lifestyle plans. **Objective:** Students will achieve a rubric score of at least 85% on the plans they produce, including specific and appropriate recommendations for lifestyle changes, exercises, and eating habits. **Assessment:** Rubric adapted from one they found online.

### Step 4: Design integration strategies.

The three teachers agreed on the following sequence of instruction and activities:

- » **Week 1: Assign the project and collect information**—In each class, describe and discuss the requirements for the project and the learning activities that will take place. **Biology class:** Assign readings and hold class discussions about body systems. To review concepts, use assignment sheets for the InnerBody Works website (<http://www.innerbody.com>) and Muscle Flash (Bonnie's Fitware). **PE/Health class:** Show the video Personal Fitness: Looking Good/Feeling Good (Kendall-Hunt). Review concepts about diet and exercise. Analyze the impact of diet with simulations such as Pyramid Challenge and DINE Healthy (DINE Systems), and analyze fitness performance and prepare fitness plans using Health-Related Fitness (Bonnie's Fitware). **Technology class:** The teacher works with the whole class to design the video structure and then forms small groups and assigns each group to work on a video depicting each student.
- » **Week 2: Prepare information and materials**—**Biology class:** The teacher assists as students finish working on their simulation assignments and as they take notes and gather materials to answer the biology questions. **PE/Health class:** Students begin their word-processed descriptions of appropriate fitness plans for their "example teenagers." **Technology class:** The small groups work on video production techniques and learning the video editing software.

## ISSUES AND PROBLEMS IN PHYSICAL EDUCATION AND HEALTH EDUCATION

Today, the health of young people—and the adults they will become—is critically linked to the health-related behaviors they choose to adopt. Because strong evidence exists that participation in health and physical education classes can help develop healthy behaviors in children, many schools, like the one in the *Personal Fitness Plans You Can Live With* example at the beginning of this chapter, are trying to find ways that all students can realize these benefits. As the example shows, technologies are available

to help teachers inform and empower students to make the right health choices. In addition, new technologies that were originally designed with entertainment in mind can help provide physical exercise. This section discusses the types of issues teachers must confront when teaching physical education and health education and when integrating technology into these topics.

### Decreasing Instructional Time for Physical Education

With schools currently refocusing their priorities on meeting standards in content areas and increasing scores on state



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» **Week 3: Prepare and display video products—Technology class:** The small groups storyboard their videos and prepare scripts based on information from the word-processed descriptions. They complete work on their videos and edit them as needed. Students present their videos to each of

the classes, and teachers use their checklists and rubrics to assess the work.

### **Step 5: Prepare instructional environment.**

The teachers check out the software and videos from the Media Center and gather the assignment sheets to be used with them. Each teacher prepares copies of the rubrics and checklists. The TE teacher agrees to put these on the website so that students can look at them online. The biology teacher decides to have students do most computer simulations at the computer lab, so he schedules times for it. Mr. Martinez coordinates which students can work in pairs or small groups and prepares materials to communicate this information to the students.

## **PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS**

### **Step 6: Analyze results. Step 7: Make revisions.**

After they completed the unit, the three teachers reviewed the videos, looked at summary data from the checklists and rubrics, and discussed how the activities progressed. They agreed that the project worked well and determined how they might share class time in the future to make the work easier to coordinate. They agreed that, although students loved the body and nutrition simulations, they were time-consuming. They decided to limit the number of simulations done inside class time and to allow students to do more on their own time for extra credit. They also found that some groups took more time with script writing than was originally planned, so their videos took more than a week to complete; this would need to be built into the plan for next time.

**Source:** Based on concepts in the Manteno (Illinois) Community Unit No. 5 School District webquest.

and national tests, programs like health instruction and physical education have suffered. Coe, Pivarnik, Womack, Reeves, and Malina (2006) say that many school districts are reducing physical education requirements and eliminating programs. The percentage of schools requiring physical education has decreased dramatically over the years. Coe et al. find that “Daily participation in physical education among high school youth at the national level is 29.1%, and participation declines as students progress through grades. . . . Physical education classes are being replaced with other classes in an effort to increase the students’ academic achievement as measured by standardized tests” (p. 591). It seems likely that emphasis on academic subjects will continue to increase in the foreseeable future, with physical

education classes becoming even less emphasized and children getting less exercise as a result.

## **The Link Between Physical Inactivity and Obesity**

Fogel, Miltenberger, Graves, and Koehler (2010) say that though the U.S. Department of Health and Human Services recommends that children get a minimum of 60 minutes of moderate to vigorous exercise daily, few meet this requirement. Physical activity levels decrease as children get older, and 75% of adolescents in grades 9–12 do not meet the national recommendations for daily physical activity. A natural outcome of decreasing activity levels is increasing numbers



of overweight children and adolescents. According to an annual report by the Trust for America's Health (Levi, Vinter, St. Laurent, & Segel, 2010), childhood obesity rates range from 9.6% (Oregon) to 21.9% (Mississippi). The average number of overweight U.S. children is around 17%, triple the 1980 rate. The decrease in required physical education courses is partly to blame for this trend, but Fogel et al. (2010) say that research indicates children are less physically active in part because they spend more of their free time indoors watching television and playing computer games rather than outside in physical play. This society-wide trend affects both the motor development and the health of our country's youth.

## Accuracy of Internet Information on Health

When young people look for information on health topics, they must have a sufficient level of information literacy to know how to locate, evaluate, and use effectively what they need. The national health standards speak directly to this issue. Because anyone can post anything on the Internet, students need to become good consumers of health and fitness products and information. Specifically, they must be able to differentiate between accurate and inaccurate information in the context of health and fitness education. Without this ability, they are unsuspecting consumers of misleading and potentially harmful advice on health matters.

## The Need to Address Physical Education and Health Standards

School physical education has come far from its early emphasis on physical training and calisthenics. It evolved into sports education; then lifetime activities; and now its current focus is on health-related fitness, behavioral competencies, and motor skills needed for lifelong engagement in enjoyable physical activity. This current shift is due, in part, to the National Physical Education Standards (see <http://www.aahperd.org/naspe/standards/nationalStandards/PEstandards.cfm>), first introduced in 1995 and updated in 2004 by the National Association for Sport and Physical Education (NASPE). The American Association for Health Education AAHE National Health Education Standards (see <http://www.cdc.gov/HealthyYouth/SHER/standards/index.htm>) were also published in 1995 and updated in 2007 (American Alliance for Health, Physical Education, Recreation, and Dance). The focus of the health education standards is health literacy—the capacity of individuals to obtain, interpret, and understand basic health information along with the competence to use such information to enhance health.

Despite their importance and relevance to the lifestyles of today's young people, the standards are not being implemented as much as is needed. This is due in part to the decreasing number of courses schools are requiring in these areas.

## Handling Controversial Health Issues

Controversial subject matter has proven to be another challenge for health education. Many special interest groups press for inclusion of their particular issue in the health education curriculum. But including too many such issues actually can water down a curriculum and make it less effective. One area of particular concern is human sexuality. Many experts believe information and guidance on sexual decisions are essential; others feel students should be taught that abstinence is the only choice and that teaching about a controversial subject tends to legitimize it in the mind of the student. Other controversial topics include date rape, suicide, drugs, violence, and character education. Sometimes the best strategy available to connect students with information they need is to refer them to a reliable Internet site or an app such as iTriage, shown in the Mobile Apps for Education feature.



## TECHNOLOGY INTEGRATION STRATEGIES FOR PHYSICAL EDUCATION AND HEALTH EDUCATION

Though technologies such as television and online social networks have caused or added to many of the health and fitness problems we are seeing in modern society, other technologies are also helping teachers address these problems. Bechtel (2010) says that 21st century physical education teachers must thread technology throughout the curriculum. Technology-enabled strategies for accomplishing this include supporting improved physical fitness, developing and improving motor skill performance, supporting students' work in dance, shaping students' beliefs and interactions related to physical activity, helping students assess and enhance personal health, helping students obtain valid health information, influencing health behaviors, supporting interdisciplinary instruction, and offering physical education and health education online. Table 1 summarizes the strategies and benefits discussed here, as well as resources to help implement them. Technology Integration Example 1 demonstrates how many of these strategies can be implemented in a classroom.



# MOBILE APPS FOR EDUCATION

## PHYSICAL EDUCATION AND HEALTH EDUCATION

App Name	Description	Device
<p><b>iTriage</b> (Symptom Checker)</p>  <p>From Healthagen.com</p>	<p>Created by two ER docs, iTriage helps you answer the questions: "What medical condition could I have?" and "Where should I go for treatment?" It also lets you save, easily access, and share the healthcare information most important to you. Search symptoms, learn about potential causes, and then be directed to the most appropriate treatment facility or doctor. Thousands of medical symptoms, diseases, procedures, and medications. The most updated and comprehensive national directory of hospitals, urgent cares, pharmacies, physicians, outpatient clinics, and community health clinics.</p>	<p>iPad, iPhone, and iPod touch</p>
<p><b>Sports Tracker</b></p>  <p>From Sports Tracker</p>	<p>Join the growing global Sports Tracker community and have fun getting fit! Capabilities allow students to: track and analyze their performances, monitor their progress; store all training data in their personal workout diary; keep track of everything from calories burned to average training speed and altitude; use maps, time and distance calculators; share workout data and photos with other trackers on Sports Tracker, Facebook, and Twitter; and explore the globe to discover new routes, trails, and adventures worldwide.</p>	<p>Android, iPad, and iPhone</p>

Source: iTriage logo courtesy of Healthagen, LLC. Sports Tracker logo reprinted by permission.

**TABLE 1** Summary of Technology Integration Strategies for Physical Education and Health Education

Technology Integration Strategies	Benefits	Sample Resources and Activities
Supporting improved physical fitness	<ul style="list-style-type: none"> <li>• Self-monitoring devices help analyze, monitor, and improve fitness</li> <li>• Exercise equipment offers exercise options while providing feedback on performance</li> <li>• Computer-based fitness planning and portfolios, nutrition programs help students set health and fitness goals and track achievement</li> <li>• Exergaming provides fun, motivational exercise options</li> </ul>	<ul style="list-style-type: none"> <li>• Heart rate monitors</li> <li>• Blood pressure devices</li> <li>• Pedometers</li> <li>• Spirometers</li> <li>• Treadmills</li> <li>• Stair steppers</li> <li>• Stationary bikes</li> <li>• Portfolio programs and websites</li> <li>• Nutritional analysis programs such as <i>DINE Healthy</i>: <a href="http://www.dinesystems.com">http://www.dinesystems.com</a></li> <li>• Nintendo Wii and Playstation Dance Dance Revolution</li> </ul>
Developing and improving motor skill performance	<ul style="list-style-type: none"> <li>• Tablet PCs assist with monitoring students' progress in the field</li> <li>• Digital video offers: models of performance to aim for, highly-visual feedback on individual performance, and aids to self-diagnose areas that need improvement</li> </ul>	<ul style="list-style-type: none"> <li>• Tablet PCs</li> <li>• Digital video cameras</li> <li>• Video editing software</li> <li>• <i>SportsCAD</i> motion analysis program: <a href="http://www.sportscad.com/">http://www.sportscad.com/</a></li> <li>• <i>Dartfish</i> Video Analysis software: <a href="http://www.dartfish.com">http://www.dartfish.com</a></li> </ul>

*Continued*

**TABLE 1 Summary of Technology Integration Strategies for Physical Education and Health Education (continued)**

Technology Integration Strategies	Benefits	Sample Resources and Activities
Supporting students' work in dance	<ul style="list-style-type: none"> <li>• Online videos (e.g., on YouTube) provide models to learn about various dances</li> <li>• Ipods allow "private performance" while in a group setting</li> <li>• <i>LabanWriter</i> lets dance students easily notate sequences of dance moves</li> <li>• Cell phones allow quick photos of dance floor plans</li> </ul>	<ul style="list-style-type: none"> <li>• Find <i>LabanWriter</i> at Ohio State University dance website <a href="http://dance.osu.edu/">http://dance.osu.edu/</a></li> </ul>
Shaping students' beliefs and interactions related to physical activity	<ul style="list-style-type: none"> <li>• Internet videos can provide provocative prompts to instigate students' writing and discussions about healthy behaviors</li> <li>• Websites such as the ePals Global Community offer ways for students in various locations to do joint projects on health issues</li> </ul>	<ul style="list-style-type: none"> <li>• <i>KidsHealth</i> website <a href="http://kidshealth.org">http://kidshealth.org</a> (look for movies under Kids and Teenagers buttons)</li> <li>• ePals Global Community: <a href="http://www.epals.com">http://www.epals.com</a></li> </ul>
Helping students assess and enhance personal health	<ul style="list-style-type: none"> <li>• Websites offer teenagers compelling tutorials to increase social-emotional learning</li> <li>• Nutritional analysis programs such as DINE Healthy and risk assessment programs allow students to track their eating habits</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ripple Effects</i>: <a href="http://www.rippleeffects.com">http://www.rippleeffects.com</a></li> <li>• <i>DINE Healthy</i> nutritional analysis software: <a href="http://www.dinesystems.com">http://www.dinesystems.com</a></li> </ul>
Helping students obtain valid health information	<ul style="list-style-type: none"> <li>• Websites offer up-to-date information to aid student research on health issues</li> <li>• Instructional media offer a variety of formats to match any student's interests and preferred learning format</li> </ul>	<ul style="list-style-type: none"> <li>• KidsHealth website: <a href="http://kidshealth.org">http://kidshealth.org</a></li> <li>• Core Learning Family Health and Health for Kids series (under Health on menu): <a href="http://www.core-learning.com">http://www.core-learning.com</a></li> <li>• BARN DVD series on health topics: <a href="http://www.lmssite.com">http://www.lmssite.com</a></li> </ul>
Influencing health behaviors	<ul style="list-style-type: none"> <li>• Videos and collaborative projects allow students to see health issues in real-life settings and view models of healthy behaviors</li> <li>• Internet sites provide helpful information to children and teens</li> </ul>	<ul style="list-style-type: none"> <li>• Webquests: <a href="http://webquest.org">http://webquest.org</a> (search on addiction and other keywords)</li> <li>• KidsHealth website (look for movies under Kids and Teenagers buttons): <a href="http://kidshealth.org">http://kidshealth.org</a></li> </ul>
Supporting interdisciplinary instruction	<ul style="list-style-type: none"> <li>• Shows links between physical education/health topics and other content areas</li> </ul>	<ul style="list-style-type: none"> <li>• Technology Integration Example 1</li> </ul>
Offering physical education and health education online	<ul style="list-style-type: none"> <li>• Provides materials to support flexible learning schedules</li> <li>• Offers information in a highly-visual format</li> </ul>	<ul style="list-style-type: none"> <li>• Distance courses</li> <li>• Wikis</li> <li>• Vodcasts</li> </ul>

## Supporting Improved Physical Fitness

Several technologies support strategies to support and motivate youngsters to increase their levels of physical activity. Several of these strategies are described here.

**Self-monitoring activities and devices.** Mears (2010) reviews devices to monitor body functions during sport and exercise activities. These include heart rate monitors (see photo), **accelerometers**, which are devices for measuring rate of acceleration, and **pedometers** (see Figure 1), which are devices that count the number of steps one takes.

## TECHNOLOGY INTEGRATION EXAMPLE 1

## TECHNOLOGY-SUPPORTED PHYSICAL EDUCATION

**TITLE:** Interdisciplinary Activities for Physical Education Concepts

**CONTENT AREA/TOPIC:** Physical education in content areas: mathematics, biology, history, geography

**GRADE LEVELS:** 6–8

**NETS FOR STUDENTS:** Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Health literacy; Information literacy: Use and manage information; ICT Literacy: Apply technology effectively

**DESCRIPTION:** Technology-based strategies can help teachers integrate physical education topics into other content areas to create interdisciplinary lessons. Students can keep personal fitness goals and achievements as part of their electronic portfolios; analyze and graph data from their use of heart monitors (mathematics); view videos that demonstrate model performances, various sports, and other motor activities to learn more about how the body works (biology); use the Internet to research sports and physical activities in other countries and historical periods (history), and do orienteering, a combination of walking, running, and hiking while following a map and using a compass or GPS (geography).

**Source:** Based on Mohnsen, B. (2000). Vaughn, Nekomi, and Luis: What they were doing in middle school physical education. *Learning and Leading with Technology*, 27(5), 22–27.

Heart rate monitors are especially effective for providing students with feedback as to whether they are in their target heart rate zones and benefiting from the training effect for cardiorespiratory endurance (Nichols, Davis, McCord, Schmidt, & Slezak, 2009). Other monitoring devices students can use include electronic **blood pressure devices** (to monitor blood pressure), **body composition analyzers** (devices to determine the percent of body fat), and **spirometers** (devices to measure lung volume). Each device measures a different aspect of health and fitness, allowing students to use their own bodies for data collection and analysis.

**Exercising with equipment and monitoring software.** Technology devices and software are available to help analyze, monitor, and improve fitness. Exercise equipment, such as

## FIGURE 1 Example Pedometer



Source: © Thinkstock

treadmills, stair steppers, and stationary bikes, are all technology devices designed to improve fitness. Used in combination with (usually built-in) monitors, these devices can show students the results of their efforts in terms of heart rate, speed, and power.

**Fitness plans and portfolios.** Students also can be put in charge of their own learning along with the development of fitness goals and plans. For example, the *Health-Related Fitness Tutorial/Portfolio* (Bonnie's Fitware) guides students through the five areas of health-related fitness: flexibility, muscular strength, muscular endurance, body composition, and cardiorespiratory endurance. The electronic portfolio portion of this software allows students to enter fitness plans, exercises, drawings or video clips, journal entries, caloric input/output, and fitness scores, which are then analyzed by the software. **Nutritional analysis programs** (software that



Heart rate monitors provide immediate feedback and promote self-awareness.

Photo courtesy of Bonnie Mohnsen.

analyzes calorie intake and monitors portions of required food groups), fitness analysis programs, and spreadsheet applications can also be used to calculate and graph individual nutrition and fitness goals.

**Exergaming.** Mears and Hansen (2009) say that **exergaming** is “video games that provide physical activity or exercise through interactive play” (p. 29). Several popular computer games such as Dance Dance Revolution and game systems such as Nintendo Wii require participants to be physically active and engaged (see Figure 2). Although this activity is not a substitute for mandatory physical education during school hours and does not require as much effort as a true sport, some physical education educators have found it to be a useful addition to their repertoire of tools (Hicks & Higgins, 2010; Klein & Simmers, 2009). Questions remain, however, about the use of exergaming (see the Hot Topic for Debate feature).

**Exercise and sport opportunities for students with special needs.** The Special Olympics have long been a way to meet the needs of students whose disabilities prevent them from engaging in other sports and exercise options. Information on how to join this program is on the Special Olympics website shown in the Adapting for Special Needs feature.

**FIGURE 2** Example of Exergaming



Source: © Shutterstock

## Developing and Improving Motor Skill Performance

Technology-based strategies are available to help students develop their motor skills at every phase of performance. Types of strategies include those for monitoring, providing feedback, self-analyzing, and developing improved skills.

### Hot Topic Debate

## SHOULD EXERGAMING BE INCLUDED IN PHYSICAL EDUCATION PROGRAMS?

*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.*

such as Nintendo Wii have become increasingly popular with people of all ages (see <http://exergamefitness.com>). As a result, young people who will not do traditional exercise enjoy playing exergames. In a 2009 article, the *Journal of Physical Education, Recreation & Dance* posed the issue of whether or not it is a good idea to make exergames an integral part of physical education curriculum in schools. Cite evidence that supports or refutes this proposal. What would be the benefits, and would they outweigh the negatives?

Technology has been cited as one of the culprits contributing to physical inactivity and resulting obesity. However, interactive “exergames” like Dance Dance Revolution and game systems

Source: Based on Should “exergaming,” or interactive video technology, be included in physical education? *Journal of Physical Education, Recreation & Dance*, 80(1), 11–13.

**Monitoring performance.** Asking students to set personal goals and then monitoring their progress on motor skill acquisition is motivational to the student but often a paperwork nightmare for a physical educator responsible for 200 to 600 students. Handheld computers help physical educators organize their data collection (e.g., grades, attendance, fitness scores) during the instructional period. Gubacs-Collins and Juniu (2009) especially recommend tablet computers for this task. Nye (2010) calls tablets “a physical educator’s new clipboard” (p. 21). After data have been transferred to a desktop or notebook computer, they can be analyzed and reported to students and parents in a variety of formats. Electronic portfolios can put students in charge of collecting, recording, and analyzing their motor skill achievement, fitness performance, social interactions, and cognitive learning (see photo below).

**Providing feedback on performance.** Once students begin to practice motor skills, feedback becomes the significant component for perfecting performance. Banville and Polifko (2009) say the research confirms that video feedback can increase the ability to learn and perform motor skills. Digital video cameras have greatly improved on the VHS machines once performance has been recorded since they allow for quick replay and analysis (see photo). The use of video is most effective when it is shown to the student immediately after the performance, along with external verbal feedback and cues. Video replay is best used with students beyond a beginner skill level. Students need some knowledge and viable mental image of the skill in order to use the information these images provide. For students with advanced skills, replay also is useful for strategy and tactics. Harris (2009) is among those who have found



Electronic portfolios can be used to record and monitor personal data.

Photo courtesy of Bonnie Mohnsen.



Video footage allows a teacher, coach, or the individual to go back and review a performance and break down stages in the skill.

Photo courtesy of Bonnie Mohnsen.



## ADAPTING FOR SPECIAL NEEDS

### Physical Education and Health Education

**S**tudents with disabilities require exercise just as any other student. However, in some cases, special considerations must be made for specific disabling conditions. School personnel should always coordinate physical education activities with the student’s family and physician. Below are some resources that can be used with all students as teachers explore the intersection of fitness, health, wellness, and technology.

- » **Special Olympics:** <http://www.specialolympics.org>—Information on sports opportunities for kids with physical and mental disabilities
- » **Centers for Disease Control:** <http://www.cdc.gov/LifeStages>—Information on health and wellness for all ages

*Contributed by Dave Edyburn*

*Dartfish Video Analysis* software helpful for analyzing movement and giving students helpful feedback, though other programs are also available for this purpose. Lim, Pellett, and Pellett (2009) point out that video editing software can also be used to clip parts of sequences to focus on desired movements (see free editing programs listed in the Open-Source feature).

**Self-analysis of performance.** To provide for student self-analysis, a digital video camera should be placed at one station in a learning circuit (e.g., for tennis skills). Each phase of the skill is modeled while students work in pairs to identify critical features, patterns, and concepts associated with the skill. Then students rotate through the stations in small groups, with one group beginning at the digital camcorder station. One student hits the ball, the second student provides feedback, and the third person records the skill performance. The student-coach uses the first set of columns on a criteria sheet to provide specific feedback. On the rotation after the video station, the students review the images. The instant replay provides immediate feedback for the performer, who uses the second set of columns on the criteria sheet to self-assess performance.

**Supporting skill development.** Student projects can be used to assess and further develop their understanding and performance of motor skills. All motor skills fall into a general movement pattern category (e.g., overhand pattern, kicking pattern). Understanding the relationship between skills using the same movement pattern helps when

transferring knowledge and experience from one motor skill to another (e.g., overhand throw to volleyball serve). Students working in small groups can investigate one movement pattern and record their findings on video. Next they can visit other classes and record examples of their particular movement pattern. Each group then shares its video with the rest of the class.

Software packages, such as *Biomechanics Made Easy* and *SimAthlete* (Bonnie's Fitware), provide reference information on the important biomechanical and motor learning concepts (e.g., goal setting, feedback, stability, force production). *Biomechanics Made Easy* then quizzes students on their understanding and application of the concepts, whereas *SimAthlete* goes a step further by asking students to create a practice plan (coach) for different athletes. The better the practice plan, the better the athlete performs during competition. *Measurement in Motion* (Learning in Motion) and *Dart Trainer* (Dartfish) take biomechanical analysis to another level by encouraging open-ended exploration. These software packages use video clips (supplied by the teacher or captured using student subjects) and allow for ease of measurement and analysis of movement performance (e.g., ball rotation, limb speed).

## Supporting Students' Work in Dance

Lepczyk (2009) discusses various ways technologies can assist students as they learn and practice dance movements.

## Free open source **OPTIONS** for Physical Education and Health Education

### TYPES

### FREE SOURCES

Dance software      *Labanwriter*: [http://dance.osu.edu/3\\_research\\_gallery/labam\\_writer.html](http://dance.osu.edu/3_research_gallery/labam_writer.html)

Video editing software      *Open Movie Editor*: <http://www.openmovieeditor.org>  
*VideoPad* video editing software: <http://www.nchsoftware.com/software/video.html>  
*Wax* video editing software: <http://www.debugmode.com/wax>

Free health software      Sheppard Software health games: <http://www.sheppardsoftware.com/health.htm>

YouTube has become a way for dance students to research and view models of various dances. Ipods make music more private so that several students can play music individually and work on their choreographies without disturbing others. Software such as *LabanWriter* permits dance moves to be more easily communicated by using the symbols for Labanotation, which was created by Rudolph Laban as a way to notate dance movements (see the Open-Source feature). Finally, cell phones are a way for students to take pictures of floor plans for dances. Lepczyk feels that technology has become a most useful means of supporting creative dance.

## Shaping Students' Beliefs and Interactions Related to Physical Activity

Standards 5 and 6 of the National Physical Education Standards address primarily the affective (attitudes) domain. Videos and online materials can provide opportunities to address these areas. Physical educators can use portions of pertinent TV programs as prompts for journal writing. For example, prompts might ask students how they would feel if presented with the situation addressed in the recording.

The Internet offers an ideal medium for connecting students of various backgrounds and beliefs and providing them with the opportunity for interactions related to physical activity (see the Top Ten feature for suggested websites). Many of us had pen pals when we were students. Today, students have epals or keypals. Keypals are students who connect with one another via electronic mail. They can share ideas, concerns, physical education/activity experiences, information, written assignments, and research. Through these connections, they learn to accept individuals from other communities and cultures. Sites such as the ePals Global Community (see <http://www.epals.com>) help teachers get started with this type of activity. They can visit one of the sites to find other physical educators interested in teaming for a class project. Another option to connect students with others for collaboration on personal fitness goals is *Sports Tracker*, an app shown in the Mobile Apps for Education feature.

## Helping Students Assess and Enhance Personal Health

When attempting to motivate individuals to change their lifestyles and adopt a wellness approach toward their health, information alone is not enough. Fortunately, online sites are available to guide students through the process of making

changes. One of these is the Ripple Effects website (<http://www.rippleeffects.com>), which offers video-based scenarios and advice on behavior issues such as bullying. The activities it provides allow students to apply their knowledge to problem-solving situations.

Many nutritional analysis programs are also currently available. These programs (e.g., DINE Systems' DINE Healthy) ask the user for data on age, weight, height, gender, and amount of physical activity, and then calculate the individual's nutritional needs. The user records the types and amounts of foods eaten daily, and the program creates a report that lists the calories ingested, the nutrient values for all foods, and the total of all nutrients ingested. These reports then are used to determine if the student has met the recommended dietary allowances and whether the number of calories ingested was excessive. These programs expose poor nutritional and fitness behaviors through their analysis of daily food intake and physical activity. Appropriate menus and exercises are recommended for a healthier lifestyle. The software packages serve as personal trainers for fitness and nutrition. Also see Technology Integration Example 2 for a useful lesson on the effects of caffeine.

Another type of useful program is a risk assessment program. These programs ask the user to input data regarding his or her lifestyle. Questions include height, weight, gender, age, cholesterol level, blood pressure, smoking habits, alcohol usage, physical activity habits, family medical history, nutritional information, and use of seat belts. Based on the data received, the program determines the individual's life expectancy, cardiovascular disease risk, and/or cancer risk.

## Helping Students Obtain Valid Health Information

Historically, the health education textbook has been the primary source of information and reading material in health education classes. Today, the Internet and various software packages provide students with access to a rich variety of additional materials. *KidsHealth* (see Figure 3) is an example of a health-related site targeted at K–12 students. Another good source is the Centers for Disease Control (CDC), which has information and materials designed for people of all ages and for special populations (see a link to the site in the Adapting for Special Needs feature). High-quality software includes the *BARNs Multimedia Series I and II* (Learning Multi-Systems) for middle and high school students, and the *Core Learning* series on health that has an appealing format and engaging activities on topics such as: The Body, Illnesses and Injuries, Staying Healthy, Becoming an Adult, and





# TOP TEN

## Websites for Integrating Technology in Physical Education and Health Education

In addition to the websites listed in this chapter, take advantage of the following websites for using technology to enhance the teaching of physical education and health education.

SOURCE	TRACK	SELECTION
<b>American Alliance for Health, Physical Education, Recreation, and Dance:</b> <a href="http://www.aahperd.org">http://www.aahperd.org</a>	1	The professional organization for educators in these areas.
<b>American School Health Association:</b> <a href="http://www.ashaweb.org">http://www.ashaweb.org</a>	2	The professional organization for health educators.
<b>Centers for Disease Control and Prevention:</b> <a href="http://www.cdc.gov">http://www.cdc.gov</a>	3	This site offers a broad range of current information on health and wellness and is an excellent source of quality information for students and teachers.
<b>Go Ask Alice:</b> <a href="http://www.goaskalice.columbia.edu">http://www.goaskalice.columbia.edu</a>	4	Students or teachers ask questions about health and wellness issues. Visitors simply send in their questions; they are answered by a team of experts from the Columbia University Health Question & Answer Service.
<b>Kids Health:</b> <a href="http://www.kidshealth.org">http://www.kidshealth.org</a>	5	Parents, children, teens, and professionals find answers to commonly asked health questions. Topics include the benefits of different types of vitamins, the food pyramid, healthy children's recipes, how to read food labels, and keeping fit.
<b>Health Teacher:</b> <a href="http://www.healthteacher.com">http://www.healthteacher.com</a>	6	Subscription-based site that offers a comprehensive, sequential K-12 health education curriculum consisting of almost 300 lesson guides that meet National Health Education Standards and provide skills-based assessment methods.
<b>Science of Sport:</b> <a href="http://www.exploratorium.com/sport/index.html">http://www.exploratorium.com/sport/index.html</a>	7	Interactive site addresses the science of sport—specifically baseball, cycling, skateboarding, and hockey.
<b>P.E. Links 4U:</b> <a href="http://www.pelinks4u.org">http://www.pelinks4u.org</a>	8	Provides information on adapted physical education, coaching and sports, elementary physical education, health and nutrition, fitness, interdisciplinary secondary physical education, and technology in physical education. Also has links to other major physical education websites.
<b>Technology in Physical Education Newsletter:</b> <a href="http://www.pesoftware.com/technews/news.html">http://www.pesoftware.com/technews/news.html</a>	9	Newsletter provides physical educators and health educators with the latest information on using technology in physical education.
<b>Kids.gov:</b> <a href="http://www.kids.gov">http://www.kids.gov</a> (click Health and Fitness link)	10	Offers a variety of helpful resources to support health and fitness for young people.



## TECHNOLOGY INTEGRATION EXAMPLE 2

### TECHNOLOGY-SUPPORTED HEALTH EDUCATION

**TITLE:** What's the Buzz? Exploring Concepts About Caffeine

**CONTENT AREA/TOPIC:** Health, biology

**GRADE LEVELS:** 8–12

**NETS FOR STUDENTS:** Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Health literacy; Creativity and Innovation: Work creatively with others; Critical Thinking and Problem Solving: Reason effectively, make judgments and decisions; Communication and Collaboration: Work creatively with others; ICT Literacy: Apply technology effectively

**DESCRIPTION:** Before the lesson begins, have students collect and bring in drink containers from items that have caffeine. Discuss how much caffeine each student has consumed in the past three days and the effect caffeine has on the human body. Read and discuss website information on the effects of caffeine (e.g., the Energy Fiend at <http://www.energyfiend.com>, and the *New York Times* online article, "A Century Later, Jury's Still Out on Caffeine Limits"). Tell the class that they will work in groups to explore how caffeine affects the body, how common it is in various consumer products, and whether its use in consumer products is regulated in any way. Then each group will be assigned a focus question and will put together a dramatic skit intended to teach their peers about their specific question. Have students use video cameras to record the skits to post on SchoolTube.

**Source:** Based on concepts from "The Buzz About the Buzz: Learning How Caffeine Affects the Body," a lesson plan at the Learning Network: Teaching and Learning with the New York Times, <http://learning.blogs.nytimes.com>.

Emotional Health (see Figure 4 for an example from The Body). Children and teenagers can use these and other resources to research health topics, including the side effects of commonly used medicines or symptoms of major medical illnesses.

Computer-mediated and online formats are also a good way for young people to obtain reliable information on topics that, due to their controversial nature, teachers may not be able to discuss through direct classroom instruction. For example, Goldsworthy and Schwartz (2008) describe an effective multimedia curriculum for sex education. Noar,

**FIGURE 3** KidsHealth Website



Source: © The Nemours Foundation/KidsHealth. Reprinted by permission.

**FIGURE 4** From *Explore Your Body* Software



Software can help promote health awareness for young children.

Source: Interactive health lesson from Core Health I Course, published by Core Learning; [www.core-learning.com](http://www.core-learning.com). Reprinted by permission.

Pierce, and Black (2010) reported a meta-analysis of studies on computer-based interventions in sex education that indicated these kinds of materials have the desired impact on attitudes and behaviors.

Buhi, Daley, Fuhrmann, and Smith (2009) say that "The Internet has become the leading source for sexual health information" (p. 101). However, as noted earlier,

students need instruction on how to distinguish between accurate and inaccurate information, so these sources must be carefully vetted before teachers recommend that young people use them.

## Influencing Health Behaviors

When dealing with all of the complex issues in health education, students frequently look for models of appropriate behavior. One way to provide these models is through working with other students like themselves who face the same kinds of problems and decisions. Classes in various parts of the world can collaborate on projects such as studying local safety or behavior issues. When they complete their research, they work together on developing a web page or other product that documents healthy behaviors. Students also are able to discuss the differences between various cultures with regard to subjects such as drug use or government-sponsored health care.

Video resources are an efficient way to remove logistical hurdles when teaching health-related issues. They allow students to hear information and advice from a voice other than the teacher's. They also allow students to see health issues in real-life settings and view models of healthy behaviors.

## Supporting Interdisciplinary Instruction

The popular opinion regarding interdisciplinary instruction for health and physical education is that these subject areas support learning in other subjects. However, the perspective of health and physical educators is that interdisciplinary instruction requires a symbiotic relationship—where subject areas support each other. Mohnsen (2003) offers an example of an interdisciplinary health-related fitness unit in which the physical education teacher focuses on the benefits of physical training and conditioning and the health education teacher focuses on health issues related to diet and physical activity. The science teacher explores how the digestive system works, and the mathematics teacher provides word problems on the input and output of calories. See Technology Integration Example 1, provided earlier in this chapter, for an example of an interdisciplinary lesson that integrates physical education, science, and math, along with the use of computers. Technology teachers can help with these interdisciplinary units by providing Internet research support and multimedia project development tools that let students demonstrate their health and physical education learning.

## Offering Physical Education and Health Education Online

A recent trend is for physical education and health education courses to be taught online. One might wonder what an online physical education course looks like. As with any course, the design and pedagogy differ greatly from class to class. However, they most commonly consist of a goal, such as walking four miles a day, that students must accomplish in a week. Students keep a log of their physical activity, sharing their data with other students while they keep a journal of their experiences. Mears (2009) reviews how podcasts and wikis can help with learning at a distance, and Shumack and Reilly (2011) feel that video podcasting (**vodcasting**) can help get needed physical education information out to students in a highly visual format. Vodcasts are simply videos posted on a course site or other website, such as YouTube, a practice that is also referred to as video sharing.

## TECH-PACK NEEDS AND CHALLENGES IN PHYSICAL EDUCATION AND HEALTH EDUCATION

Though physical education and health education are critically important topics, they are not receiving as much attention in American education as they once did. Required physical education courses are decreasing in today's schools and, as a consequence, young people are becoming both less physically active and less aware of how to adopt a healthy lifestyle. To make up for this deficit, it increasingly falls to teachers in all content areas to work with physical education and health teachers and do whatever they can to encourage physical activity and promote health awareness. Technologies can help teachers as they integrate health and physical fitness principles in their curricula. First, though, they must become aware of the physical education and health content standards, as well as specific technologies available to assist them and pedagogical strategies to integrate these technologies most effectively.

## Physical Education and Health Education Content Knowledge

Though physical education and health education teachers are likely well-versed in content standards for these areas, teachers

in other content areas usually are not. Many of today's school students take few or no physical education classes, so other classes they are required to take must help provide the necessary content. The challenge for all teachers in the area of physical education and health education content knowledge is to become more aware of the content standards for these areas and their relevance to today's young people. Children who are not as physically fit and healthy as they should be cannot learn any content as efficiently as students who do meet these criteria. Thus, it is to the advantage of all educators to learn more about physical fitness and healthy behaviors.

## Physical Education and Health Education Pedagogical Knowledge

If content area teachers are to integrate physical education and health concepts into their curriculum, they must work closely with physical education and health teachers. Collaborative projects like the one described at the beginning of this chapter are an example of how teachers can work together to engage students in required content on physical fitness and healthy lifestyles. Working this content into already-full curriculum in areas such as math, science, and language arts will take creative lesson planning on the part of everyone. Creating classroom contexts for strategies such as video monitoring projects (e.g., in technology classes), physical fitness planning (e.g., in math classes), and use of monitoring devices (e.g., in science classes) will be essential.

## Physical Education and Health Education Technological Knowledge

Strategies to teach physical education and health education content are heavily dependent on various technologies that may be completely new to many teachers outside of physical education and health. This means that teachers must become acquainted with new software such as nutrition simulations, nutritional analysis programs, and games for health awareness; devices such as pedometers and heart rate monitors; and video development and vodcasting.

## Strategies for Improving Tech-PACK in Physical Education and Health Education

Strategies for improving Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After

reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

- » **Do I have the physical education and health education content knowledge I need to assist my students in meeting the standards within my classroom?** The biggest challenge to teachers outside physical education and health is to add to their content knowledge in these areas. Though this will be a considerable assignment in light of their other responsibilities, increased awareness of the role that fitness and healthy lifestyles play in our lives will benefit everyone, young people and educators alike. Teachers' work with other teachers who already have this content knowledge will be essential.
- » **Do I have the pedagogical knowledge needed to teach the physical education and health content within my classroom?** Content-area teachers will have to rely on physical education and health education teachers to work with them and provide some of the background they need to implement interdisciplinary projects like the one described at the beginning of the chapter. In addition, teachers of physical education and health will have to rely on professional development opportunities to update their own pedagogical strategies for integrating newer technologies. The American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD) website offers many of its own professional development workshops and advertises ones sponsored by its regional affiliates (see <http://www.aahperd.org> for these opportunities). There are also organizations for each of the disciplines within the umbrella of content areas that AAHPERD covers. These include:
  - The American Association for Health Education (AAHE): <http://www.aahperd.org/aahe>
  - The American Association for Physical Activity and Recreation (AAPAR): <http://www.aahperd.org/aapar>
  - The National Association for Girls and Women in Sport (NAGWS): <http://www.aahperd.org/nagws>
  - The National Association for Sport and Physical Education (NASPE): <http://www.aahperd.org/naspe>
  - The National Dance Association (NDA): <http://www.aahperd.org/nda>

- Council for Children's Expanded Physical Education (CCEPE): <http://www.ccepe.net>
- The American School Health Association (ASHA): <http://www.ashaweb.org>

» **Do I have the technological knowledge needed to teach the physical education and health content within my classroom?** Even physical education and health education teachers may be unfamiliar with newer technologies such as exergaming, nutrition simulation programs, and vodcasting. So that they may become school leaders in using and teaching others about these technologies, they will have to look for workshops provided by their professional

organizations to update their technology knowledge. Again, the organization websites mentioned above are primary sources for professional development opportunities.

As part of the exercises at the end of this chapter, you will deconstruct a teacher's Tech-PACK based on what you know of their knowledge and what must be learned to teach physical education and health education effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone in your own content area.



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## SUMMARY

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

**1. Issues and Problems in Physical Education and Health Education**—Each of these current issues has implications for how teachers can and should integrate technologies. These include: decreasing instructional time for physical education, the link between physical inactivity and obesity, accuracy of Internet information on health, needs to address standards in physical education and health education, and how to handle controversial health education issues.

**2. Technology Integration Strategies for Physical Education and Health Education**—Technology-enabled strategies in these areas include: supporting improved fitness, developing and improving motor skill performance, supporting students' work in dance, shaping students' beliefs and interactions

related to physical activity, helping students assess and enhance personal health, helping students obtain valid health information, influencing health behaviors, supporting interdisciplinary instruction, and offering physical education and health education online.

**3. Tech-PACK Needs and Challenges in Physical Education and Health Education**—To integrate technologies effectively, teachers must have a combination of physical education and health education content knowledge, pedagogical knowledge, and technological knowledge. Strategies for improving your Tech-PACK in physical education and health education are recommended.



# ISSUES

## for Collaborative Discussion and Reflection

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

**1.** In his 2009 article on the ESPN website, Mark Fainaru-Wada said that, "There's a childhood obesity crisis in the country, virtually any expert will tell you...increasingly sedentary lifestyles driven by video games, television, and computers; a fast-food society in which soda machines and greasy cafeteria food are ubiquitous in kids' lives; and dwindling opportunities for exercise, particularly during the school day." In this chapter, you've read some of the ways technologies can help address this situation. Do you feel these technology-based strategies will be sufficient to

counter the harm caused by the other technologies the author mentions? What conditions will have to be in place for these strategies to make a difference?

**2.** Although physical education courses can be (and are being) taught online (see the online article, "P.E. Goes Virtual" at the WCTV website, <http://www.wctv.tv>), what are the issues and problems you see associated with these kinds of courses? How would you recommend teachers address each of these issues and problems?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationLab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- b. Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- a. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology (ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- b. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- c. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Ms. Belt is an experienced biology teacher who sees the growing problem of obesity in young people in her own ninth and tenth grade students. She feels that more could be done to teach them during her classes about nutrition and body functions and, thus, influence their eating and exercise habits. She knows that all her students are avid technology users and would respond well to lessons that used devices and computer resources. Yet she doesn't know where to begin researching lessons of this kind. She goes to the technology education teacher, who agrees to work with her, but reminds her that he knows little about health education topics. She would have to supply that information to him.*

- a. Deconstruct Ms. Belt's Tech-PACK in the following way. Fill in the following matrix to show what she knows and what she will have to learn in terms of content, technologies, and pedagogies in order to be in her Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that she must address to implement this new strategy effectively in her classroom.

## 5. WHAT'S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the "What must be learned" column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.



**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.



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# TEACHING AND LEARNING WITH TECHNOLOGY IN SPECIAL EDUCATION

# TEACHING AND LEARNING WITH TECHNOLOGY IN SPECIAL EDUCATION

For most of us, technology makes things easier. For a person with a disability, it makes things possible.

Judy Heumann, American Disability Rights Activist and Former Assistant Secretary, U.S. Department of Education, Office of Special Education Programs

## o u t c o m e s

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

1. Articulate a rationale for including technology in curriculum for special education that is based on the goals of meeting individual needs of each student.
2. Recognize the implications for technology integration of each current issue faced by teachers of students with special needs.
3. Create key strategies for integrating technology into special education curricula.
4. Analyze given scenarios to identify examples of Tech-PACK needs and challenges that are specific to teachers of students with special needs.



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## key terms

alternative keyboard  
assistive technology  
closed-circuit television  
(CCTV)  
compensation  
disability  
FM amplification system

handicap  
impairment  
inclusion  
joystick  
mainstreaming  
optical character recognition  
(OCR)

remediation  
screen reader  
sensory disabilities  
switch  
universal design  
web accessibility



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## TECHNOLOGY INTEGRATION IN ACTION: HELPING STUDENTS WITH DISABILITIES BLEND IN

GRADE LEVEL: All grade levels • CONTENT AREA/TOPIC: Research methods, data analysis, charting, graphing • LENGTH OF TIME: Three weeks

### PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

#### Step 1: Determine relative advantage.

Three of the students in Ms. Montoya's sixth grade class had special needs. Dorothy had cerebral palsy and came to class in her motorized wheelchair. Although bright and enthusiastic, she had difficulty with fine-motor skills and could not write or use the computer keyboard and mouse. Ralph was a shy, sweet boy with mild mental deficits. Geraldo had hearing impairments and was reluctant to speak in class. Ms. Montoya made special efforts to involve Dorothy, Ralph, and Geraldo in all class activities and had shown the other students how to welcome them into their work and play. She consulted with the school district's Special Education Resource Office to obtain an alternate keyboard and input software for Dorothy and special speech development software for Geraldo. She tried several resources and strategies to help develop Ralph's reading skills and found that he especially liked working with interactive books. However, she wanted to organize a class project that would involve all her students and show that

each one of them could make a valuable contribution to the work despite their varying talents and ability levels. She learned in a district workshop about curriculum blending or curriculum overlapping, the practice of having students at all ability levels (including those with physical or learning disabilities) work on the same activities, but grading them differently. She decided to do a curriculum blending project that involved having the class do a survey of students in the school. Dorothy and Geraldo and others would be put in charge of gathering the data using an alternative input and spoken word processor system recommended by the Special Education Resource Office. The system could voice the questions, and students could enter their responses directly onto a touch panel on the computer screen or an iPad. Ralph could work in the group that did initial tasks in the data analysis, and the whole class could learn how to do research and ask different levels of "what if" questions from compiled data. She correlated several required math skills with these activities.

#### Step 2: Assess Tech-PACK.

Ms. Montoya really wanted to make a difference, but she was concerned about her ability to infuse technology, pedagogy, and content into her classroom. Thus, she did a Tech-PACK



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self-assessment of her knowledge to see where she was deficient and how she might capitalize on her strengths.

**Content Domain.** Ms. Montoya had been teaching for over ten years and realized that her content knowledge was quite strong. She had a clear understanding of the state standards her students were required to meet and the content that she needed to teach to assist her students in meeting those standards.

**Content and Pedagogy Domains.** Ms. Montoya also felt very confident about her content and pedagogical knowledge. Over 95% of her students had passed the state standards tests over the past five years. She felt that her pedagogical strategies were time proven.

**Technology Domain.** Ms. Montoya realized that her pedagogical and content knowledge were very strong compared to her technological knowledge. However, because she would have the assistance of the individuals who held the district workshop on curriculum blending, she felt it was fine to move forward with her plan.

## PHASE 2 PLANNING FOR INTEGRATION

### Step 3: Decide on objectives and assessments.

Ms. Montoya developed an assignment sheet for each student that indicated which tasks they would be required to do and how they would be graded. The sheets were tailored to the ability and skill levels of each student. Although tasks were different, criteria were similar and included accomplishing all tasks, working with others in the group, and completing a required product. Ms. Montoya stated the outcome as follows:

- » **Outcome:** Survey completion and data analysis. **Objective:** Students will complete each of their assigned tasks to complete the survey activity, analyze and display the data, and complete a bulletin board showing their work. **Assessment:** Checklist of survey/product tasks with points assigned to each task.

### Step 4: Design integration strategies.

Ms. Montoya designed the following sequence of activities around a survey of the students in the school.

- » **Week 1:** Introduce the survey project and educate the students. Give students the assignment sheets and discuss the purposes and uses of survey research. Work with them to design a simple "script" for the survey and to enter it into the voice word processor, and show them how the input system works to collect data. Have them discuss methods of getting students to stop and complete the survey (e.g., offer them a sticker that says "I voted!" as some voting places do on

## INTRODUCTION TO SPECIAL EDUCATION

Education for students with special needs encompasses strategies for both those with physical and/or mental deficits and those with special gifts or talents. Although technology can be used to enhance education for both populations, this chapter addresses primarily applications for students with disabilities.

While the terms impairment, disability, and handicap are often used synonymously, differences among these concepts have important implications for the use of technology in classrooms. An **impairment** involves an abnormality or loss of function in a physical, anatomical, or psychological structure. Impairments to human function may be congenital (present at birth) or acquired through accident or disease.

It is important not to make assumptions concerning a person's ability or limitations simply because he or she has an impairment.

When an impairment limits an individual from performing an activity in a manner normally expected for human beings (communicating with others, hearing, movement, manipulating objects, and so on), we refer to this as a **disability**. A student who has lost the function of his right arm has an impairment; this condition will have little or no impact on a variety of life functions. However, this student may encounter situations where the inability to use two arms places him at a disadvantage with others. A **handicap** arises when an individual is unable to fulfill a role due to an impairment or disability. It is critical to understand that a handicap is not a characteristic of an individual, and thus, the term is neither used to describe an individual nor the condition of a disability or impairment. Instead, its use is

election days). Have students rehearse the sequence in advance so that it will move quickly when they actually begin the survey.

» **Week 2:** Do the survey. Select a location (e.g., near the library) for data collection. Ask Geraldo to be in charge of encouraging students who pass by to participate in the survey. Place Dorothy in charge of demonstrating how the input system works. To get the question presented, a student touches a question icon, and the computer gives a typed and a voice response that states the question. Then the student answers the question by touching answer icons.

» **Week 3:** Show the whole class how to analyze the results, and do a summary product (e.g., a bar graph) based on the results. For example, ask students to calculate percentages (e.g., What percentage of the population is male? Female?) and query the data (Do male students tend to prefer a certain sport?). Have Ralph work on the computer to sort and organize the responses for each query. Divide students into small groups, and have them do their own queries and bar graphs. Have all the students help prepare a bulletin board to post their findings for the school to see. Place pictures of the students around the bulletin board, identifying the roles they played in the survey activity.

### Step 5: Prepare instructional environments.

Ms. Montoya worked closely with the special education personnel to set up the special computer system and learn how to use it. She obtained permission to have the “survey station” in the hall outside the library and asked the main office to publicize the survey in the morning announcements. She spent extra time with Geraldo and Ralph to prepare them for their roles.

restricted to identifying the impact or consequence of the disability on the individual (Gargiulo, 2012). A handicap is the “negative consequence of an impairment. It may be a problem with access to certain buildings and facilities caused by poor walking, it may be difficulties in conversations caused by poor speech, or it may be difficulties in an education caused by poor reading ability” (Elbro, 2010, p. 470).

In the United States, federal law recognizes several types of disabilities. Most citizens are likely to know one or more individuals whose life function has been affected by disability in some form: deaf, hard of hearing, mental retardation, multihandicapped, orthopedically impaired, other health impaired, seriously emotionally disturbed, specific learning disability, speech impaired, or visually handicapped.

The fields of special education and rehabilitation have had a long-standing interest in technology. Special education technology has been a part of the United States educational

## PHASE 3 POST-INSTRUCTION ANALYSIS AND REVISIONS

### Step 6: Analyze results.

At the end of the unit, Ms. Montoya reviewed the project and reflected on its impact. Some of the questions she asked were the following:

- » Did students at all ability levels accomplish their required tasks?
- » Did students (including those with special needs) seem engaged in the learning?
- » Did students (including those with special needs) seem to acknowledge that all of them had made a valuable contribution to the class?
- » Did the alternative computer system work smoothly?

### Step 7: Make revisions.

Ms. Montoya was happy with how involved the students were in the survey. Parents of all three students with special needs came by to see the bulletin board and to express their pride in their children’s work. Ms. Montoya and the principal agreed that they would have to work on relocating the computer station so as not to disrupt hall traffic, since the “talking computer” drew quite a crowd. However, the principal also asked her to share her project with other teachers who had students with special needs.

**Source:** Based on a concept from “Curriculum Blending: Surveying Activities for Everyone” in *Learning and Leading with Technology*.

system since at least 1879, when the United States Congress made a \$10,000 grant for the production of Braille materials by the American Printing House for the Blind. In 1958, funding was provided for captioning films for the deaf. These are just two examples of laws whose purpose was to improve instruction via technology for people with disabilities. As technology became more visible within the educational setting, the federal government established two Special Education Instructional Materials Centers (SEIMCs), whose purpose was to explore ways to make educational technologies more accessible to special education teachers. The two original SEIMCs eventually expanded to a network of 14 regional SEIMCs, the Council for Exceptional Children ERIC Clearinghouse, four Regional Media Centers for the Deaf, and a Network Coordinating Office. Thanks to the establishment of SEIMCs (although they were later disbanded), we have today the Council for Exceptional Children’s (CEC)

Technology and Media (TAM) Division, which publishes the *Journal for Special Education Technology* (JSET). Historically, the emphasis on technology for individuals with disabilities has been thought of as **assistive technology**—that is, extending the abilities of an individual in ways that provide physical access (e.g., wheelchairs, braces) and sensory access (e.g., Braille, closed captioning). However, technology can also help address special teaching and learning needs. In this chapter, we use the term special education technology to cover both dimensions—assistive technology and instructional technology.

Regardless of the specific application of technology, the general goal is always the same: to harness the potential of technology in ways that offer an individual with a disability increased opportunities for learning, productivity, and independence—opportunities that otherwise would not be available. In the next section, we explore several issues involved in capturing the potential of technology for individuals with disabilities.

## ISSUES AND PROBLEMS IN SPECIAL EDUCATION

A number of issues affect the delivery of special education services. The following sections briefly identify six current issues that have an impact on the use of technology in special education.



Historically, the emphasis on technology for individuals with disabilities has been thought of as assistive technology, but technology tools can also help address special teaching and learning needs.

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## Legal and Policy Directives

Special education, more than other areas of education, is governed by laws and policies. This means that teachers, administrators, and special education technology specialists must be well versed in federal and state laws, policies, and procedures. To learn more about the legal and policy foundations of the field of special education technology, consult the following resources: McLaughlin (2010), Jones (2010), and U.S. Department of Education (2011).

The following federal laws promote the use of technology by individuals with disabilities:

- » The Technology-Related Assistance Act for Individuals with Disabilities (Public Law 100–407), passed in 1988, provides funding for statewide systems and services to provide assistive technology devices and services to individuals with disabilities.
- » Reauthorization of the Individuals with Disabilities Education Act (IDEA) in 1997 (Public Law 105–17) mandates that every individualized education program (IEP) team “consider” assistive technology when planning the educational program of an individual with a disability. The most current reauthorization in 2004 contains no new technology information, but serves to reemphasize to schools the importance of academic achievement by students with disabilities and the need to help each student meet achievement goals.

## Implications of the No Child Left Behind Act for Special Education

The federal education policy the No Child Left Behind (NCLB) Act introduced a set of guidelines for public schools to improve education through the following changes: heightened accountability, enhanced flexibility and local control of funds, enhanced parental choice, and increased use of research-based instructional methods (Eisenhart & Towne, 2003). NCLB has had a significant influence in special education, as it has in all other areas of education. Perhaps one of the most important components of the law focuses on Adequate Yearly Progress (AYP), which requires documentation that each school is meeting specific performance criteria established in the law. One benefit of these AYP requirements is that they focus public attention on the persistent underachievement of students with physical disabilities.

Vannest, Mahadevan, Mason, and Temple-Harvey (2009) studied educator and administrator perceptions on the impact of NCLB. Their study found the perceptions of the impact of NCLB to be strongly positive with regard to special education in (1) teacher and paraprofessional

qualifications, (2) the use of evidence-based practices, and (3) high standards for all students. Burns and Ysseldyke (2008) studied the evidence-based practices when educating pupils with disabilities. They reported that direct instruction is the most frequently used instructional methodology and that perceptual-motor training is the least frequent. Special education teachers also reported using ineffective approaches (social skills training) as frequently as they did those approaches with a strong research base (applied behavior analysis).

### Trends in the Prevalence of Autism

The number of children with autism receiving special education and other services has increased steadily in the United States since the early 1990s and it is unclear how long this trend will continue or whether it is leveling off. Maener and Durkin (2010) noted that recent studies have reported that the prevalence of autism exceeded 1% of children in some populations and has led to widespread public concern about a possible epidemic of autism. In the United States, annual special education enrollment data indicated that the number of children who received special education services under the autism reporting category increased by 13%, to 28% each year, and by 1700% overall between 1992 and 2008.

To address this trend, there has been the development of numerous video capture and editing solutions. One such solution is video modeling where learners watch a video of a person completing a certain targeted behavior followed by the learner practicing the behavior via video. Feedback is then provided in numerous ways of which one is where a learner and teacher watch video footage of the learner's performance while the teacher provides consequences for appropriate or non-appropriate behavior (LeBlanc, 2010). There are also numerous mobile apps that assist students

with autism as well as other needs (see Mobile Apps for Education).

### American Sign Language

American Sign Language (ASL) has been recognized as a world language and has become the third most widely used language in America preceded only by English and Spanish. In fact, Miller, Hooper, Rose, and Montalto-Rook (2008) reported that between 1998 and 2002, enrollment in ASL post-secondary instruction increased 433% nationally, representing the largest enrollment percentage gain of all world languages. To address this need for an increase demand for instruction and assessment in ASL, Dr. Charles Miller from the Learning Technologies Media Lab at the University of Minnesota developed Avenue ASL. The Avenue ASL (see Figure 1)

FIGURE 1 Avenue ASL




Source: Avenue ASL: Learning Technologies Media Lab, University of Minnesota, <http://it.umn.edu>. Reprinted by permission.



# MOBILE APPS FOR EDUCATION

## SPECIAL EDUCATION

App Name	Description	Device
 <p><i>Turn Taker</i></p>	The <i>Turn Taker</i> uses visual and/or audio cues to facilitate turn taking and/or sharing in children diagnosed with an autism spectrum disorder, Down syndrome, or other special need. This app has also been used successfully with young children, children diagnosed with ADHD, and with any child who finds it difficult to share!	Android

Source: *Turn Taker* app reprinted by permission, <http://touchautism.com>.



e-assessment environment is composed of four layers that establish the following:

1. a platform for students to capture, submit, and archive ASL performances;
2. a setting for instructors to evaluate and report student performance;
3. a portfolio where students can monitor their personal performance; and
4. an administration component to manage and coordinate performance and evaluation data.

It is these types of video-based environments that are designed with aesthetic in mind that motivate student learners and also increase the efficiency of feedback. To date, more than 3 million student performances have been recorded in the environment, representing the largest library of student ASL videos available.

## Need for Trained Personnel

Considerable effort has been devoted to identifying the knowledge and skills needed by teachers (Parette & Peterson-Karlan, 2010) and specialists (Edyburn, 2010) to use technology in special education. Individuals can use the NETS competency statements to document their experience, knowledge, and skills in their own teaching portfolio. University teacher preparation programs and in-service workshop providers can review the NETS competency frameworks and align individual competency statements with specific courses and training events in order to communicate the specific outcomes participants will gain.

Despite the efforts on the part of most universities to improve the preparation of teachers to use technology in the classroom, most teachers begin their career with minimal experience using technology in ways that (1) enhance their own productivity, (2) enhance the effectiveness of instruction and the success of all students, and/or (3) enable them to acquire and use assistive technology for students in need of performance support. The common three-credit course, first developed in the 1980s, continues to be the norm for preparing teachers; unfortunately, it is generally inadequate in exploiting the power and possibilities that technology offers.

## Requirements for Inclusive Classrooms

During the 1990s, a major change occurred in how special education services were delivered. Rather than placing students with disabilities in separate classrooms (self-contained special education) and allowing them to participate in

selected classes in general education, a process called **mainstreaming**, efforts were made to include them in the general education classroom, an activity known as **inclusion**. This philosophical shift has been controversial. Nonetheless, students with disabilities now spend the majority of the school day in general education classrooms and receive a variety of support services (Suter & Giangreco, 2009; U.S. Department of Education, 2005).

Although students with disabilities have gained physical inclusion into general education, access to the general education curriculum is still limited. That is, without appropriate modifications, for instance, a student in a wheelchair cannot conduct the same science experiment as everyone else because her wheelchair cannot get close enough to the lab bench for the student to manipulate the chemicals and beakers. Likewise, when the bulk of subject matter content is contained in teacher-made materials and textbooks, a significant portion of special education students do not have access to the information they are expected to learn (e.g., students who are blind, have learning disabilities, or cannot read at grade level). With the NCLB expectation that all students will achieve high academic standards, there is an urgent need for assistive technology to help students in the general education classroom succeed.

## Universal Design for Learning

Principles of **universal design** have emerged from our understanding of the design of physical environments for individuals with disabilities. Perhaps the best example of the success of universal design principles is curb cuts. Originally designed to improve mobility for people with disabilities within our communities, curb cuts not only accomplish that but also improve access for people with baby strollers, roller blades, bikes, and so on. More recently, universal design concepts have been applied to computers by including disability accessibility software as part of the operating system so that access is provided as the computer comes out of the box (rather than requiring that an individual track down assistive technology specialists to make specialized modifications). Today, accessibility control panels are available on every computer.

In the past few years, a concerted effort has been made to apply universal design principles to learning. A leader in the area of universal design for learning has been the Center for Applied Special Technology (CAST). CAST considers universal design to be a critical issue if students with disabilities are going to be able to access the general education curriculum. In 1999, CAST, in collaboration with the U.S. Department of Education's Office of Special Programs, established the National Center on Accessing the General Curriculum (NCAC) to help create practical approaches for improved access to the general curriculum by weaving

together new curricula, teaching practices, and policies. NCAC completed its funded work in November 2004, but its publications are available through CAST. To learn more about universal design and access to the general curriculum, visit the National Center for Accessing the General Curriculum online.

Teachers working with students within inclusion settings face a relentless demand to modify curricular, instructional, and assessment materials. Modifications will always be necessary as a result of technology, media, and materials that are not designed with an understanding of the range of diversity found in every classroom. It is also important to note that modifications are always reactive, meaning that students with disabilities experience a delay in obtaining information that is readily available to their peers without disabilities. Universal design seeks to alter this paradigm by providing a new way of thinking about access that is proactive rather than reactive. Figure 2 showcases version 2.0 UDL guidelines that outline the three principles that guide universal design for learning: representation, expression, and engagement (CAST, 2011). Check out the Hot Topic Debate feature for this chapter related to universal design. Does online learning discriminate against students with disabilities?

## Web Accessibility

There has been a recent push to make websites more usable by people with various disabilities. This practice is referred to as **web accessibility** and consists of designing websites with a set of criteria in mind, such as using text equivalents with screen readers, using large or enlargeable images for

people with low vision, underlining links as well as coloring them for users with colorblindness, and making pages navigable using the keyboard only. Like universal design for learning, the intention of web accessibility is to provide greater access to information for all users by designing websites for accessibility from the ground up. Resources are available online to provide guidelines for web accessibility, including the following:

- » Web Accessibility Initiative— <http://www.w3.org/WAI>
- » IllinoisCenterforInformationTechnologyAccessibility— <http://html.cita.uiuc.edu>
- » *Building Accessible Websites* by Joe Clark— <http://joelclark.org/book>

There are also more and more open-source software options (see Open-Source Options).

## TECHNOLOGY INTEGRATION STRATEGIES FOR SPECIAL EDUCATION

This section provides information about general approaches to using assistive and instructional technology for students with special needs and describes specific products that are commonly integrated into curricula for helping achieve academic, behavioral, or social goals. Table 1 summarizes all these strategies.

### Foundations of Integration Strategies

Special educators must be concerned with two types of technology: assistive technology and instructional technology. Technology integration efforts must include both types of technology. Historically, the emphasis on technology for individuals with disabilities has been in the area of assistive technology. Indeed, the legal definition of assistive technology is considerably broad:

**§300.5 Assistive technology device.** As used in this part, assistive technology device means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability. (Authority: 20 U.S.C. 1401(1))

The assistive technology evaluation process generally seeks to identify solutions on a continuum involving no-technology (“no-tech”), low-technology (“low-tech”), and

**FIGURE 2** Universal Design for Learning Guidelines



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## DOES ONLINE LEARNING DISCRIMINATE AGAINST STUDENTS WITH DISABILITIES?

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.

Online learning is growing exponentially for students of all ages. As online learning grows, the advantages and disadvantages of this mode of learning are becoming readily present. However, what is missing in this discussion is the role

of online learning for students with disabilities. One approach that has gained a great deal of attention is universal design for learning. Rose and Meyer (2002) addressed this issue in their book, *Teaching Every Student in the Digital Age: Universal Design for Learning*, as they explored not only the concept of universal design, but how it can be used to meet the needs of all learners. More recently, Anderson (2008), in *The Theory and Practice of Online Learning*, identified a broad list of services required for online learners with disabilities. There are many challenges to educating students online, and it is more important than ever that we know the capabilities of our learners. Do you believe online learning discriminates against students with disabilities? What evidence in research or practice can you cite to support or refute your position?

## Free open source **OPTIONS** for Special Education

### TYPES

### FREE SOURCES

Text reader

Power reader: <http://www.projectpossibility.org/viewProject.php?id=1>

Web-based social stories

Web-based social stories: <http://www.projectpossibility.org/viewProject.php?id=27>

Sign language recognizer

Sign language recognizer: <http://www.projectpossibility.org/viewProject.php?id=30>

advanced technology (“high-tech”). No-tech solutions are strategies such as teaching a person to use his or her body in a different manner to minimize the impact of an impairment (e.g., one-handed typing). The obvious advantage to solutions involving no technology is that they are available in any environment at any time. Low-tech solutions are generally considered to be nonelectrical. Personal word lists,

highlighting markers, and organizing systems are all examples of low-technology solutions that can provide a person with appropriate levels of support to be successful in specific tasks. These solutions tend to be relatively inexpensive but quite flexible for enhancing individual performance. High-tech solutions are complex electrical or hydraulic systems (e.g., stair lift, powered wheelchair, voice-activated environmental

**TABLE 1 Summary of Technology Integration Strategies for Special Education**

Target Groups	Sample Technology Integration Strategies	Sample Resources and Activities
Students with mild and moderate to severe cognitive disabilities	<p><b>For individuals with mild cognitive disabilities:</b></p> <ul style="list-style-type: none"> <li>• Reading: Use reading skill software, text-to-speech products, and interactive storybooks.</li> <li>• Writing: Use voice recognition software and word prediction software.</li> <li>• Mathematics: Use graphing software, drills, games, and tutorials.</li> </ul> <p><b>For individuals with moderate to severe cognitive disabilities:</b></p> <ul style="list-style-type: none"> <li>• Software helps teach/reinforce functional skills (e.g., money management, daily living, employability).</li> <li>• Videos enhance acquisition, maintenance, and transfer of functional and community-based behaviors.</li> </ul>	<ul style="list-style-type: none"> <li>• WizCom's Quicktionary Reading Pen <a href="http://www.wizcomtech.com">http://www.wizcomtech.com</a></li> <li>• Don Johnston's <i>Co: Writer and Write: OutLoud</i> <a href="http://donjohnston.com">http://donjohnston.com</a></li> <li>• Dragon Talk's <i>Dragon Naturally Speaking</i> <a href="http://www.dragontalk.com">http://www.dragontalk.com</a></li> <li>• Freedom Scientific's WYNN word processing software <a href="http://www.freedomscientific.com">http://www.freedomscientific.com</a></li> <li>• AbleNet, Inc. <a href="http://www.ablenetinc.com">www.ablenetinc.com</a></li> <li>• Attainment Company <a href="http://www.attainmentcompany.com">http://www.attainmentcompany.com</a></li> </ul>
Students with physical disabilities	<ul style="list-style-type: none"> <li>• Provide alternative methods of accessing keyboard, mouse, and/or monitor.</li> <li>• Determine the best placement of adaptive technologies, and provide training to ensure the student is able to operate it independently.</li> <li>• Monitor function to ensure maximum level of participation is obtained without undue physical demands.</li> </ul>	<ul style="list-style-type: none"> <li>• Able Net, Inc. <a href="http://www.ablenetinc.com">http://www.ablenetinc.com</a></li> <li>• Adaptivation, Inc. <a href="http://www.adaptivation.com">http://www.adaptivation.com</a></li> <li>• Enabling devices <a href="http://www.enablingdevices.com">http://www.enablingdevices.com</a></li> <li>• Intellitools <a href="http://www.intellitools.com">http://www.intellitools.com</a></li> <li>• ORCCA technology <a href="http://www.orcca.com">http://www.orcca.com</a></li> </ul>
Students with sensory disabilities	<p><b>For individuals who are blind:</b></p> <ul style="list-style-type: none"> <li>• Use canes and sensor technologies to assist movement.</li> <li>• Use text-to-Braille converters.</li> <li>• Use screen readers.</li> </ul> <p><b>For individuals who are visually impaired:</b></p> <ul style="list-style-type: none"> <li>• Use closed-circuit television (CCTV) magnification systems.</li> <li>• Use built-in computer screen magnification control panels.</li> </ul> <p><b>For individuals who are hearing impaired:</b></p> <ul style="list-style-type: none"> <li>• Use FM amplification systems (assistive listening devices).</li> </ul>	<ul style="list-style-type: none"> <li>• VisionCue <a href="http://www.visioncue.com">http://www.visioncue.com</a></li> <li>• Dolphin Computer Access, LLC <a href="http://www.yourdolphin.com">http://www.yourdolphin.com</a></li> <li>• Freedom Scientific Blind/LowVision Group <a href="http://www.freedomscientific.com">http://www.freedomscientific.com</a></li> <li>• TeleSensory <a href="http://www.telesensory.com">http://www.telesensory.com</a></li> <li>• AudioEnhancement <a href="http://www.audioenhancement.com">http://www.audioenhancement.com</a></li> </ul>
At-risk students	<ul style="list-style-type: none"> <li>• Locate software and websites that provide powerful and motivating opportunities to engage in learning activities.</li> <li>• Utilize electronic quizzes and other instructional materials that provide immediate feedback on performance.</li> </ul>	<ul style="list-style-type: none"> <li>• BrainPop <a href="http://www.brainpop.com">http://www.brainpop.com</a></li> <li>• Don Johnston, Inc. <a href="http://www.donjohnston.com">http://www.donjohnston.com</a></li> <li>• Tom Snyder, Inc. <a href="http://www.tomsnyder.com">http://www.tomsnyder.com</a></li> </ul>
Students with gifts and talents	<ul style="list-style-type: none"> <li>• Locate starting point web pages to launch them into content with appropriate challenges.</li> <li>• Provide tools for engaging in self-directed research.</li> <li>• Provide tools such as multimedia presentations, web page design, and electronic portfolios to document learning experiences.</li> </ul>	<ul style="list-style-type: none"> <li>• Duke TIP program <a href="http://www.tip.duke.edu">http://www.tip.duke.edu</a></li> <li>• Hoagies' Gifted Education Page <a href="http://www.hoagiesgifted.org">http://www.hoagiesgifted.org</a></li> </ul>

control). Clearly, high-tech solutions tend to be the most costly and have the greatest number of restrictions regarding their use (e.g., user skill level, limited portability).

Professional practice in special education calls for the evaluation of potential solutions beginning with no-tech, continuing to low-tech, and then going to high-tech, as the needs dictate. For example, spelling words is most efficient when they are committed to memory. However, if a person displays persistent difficulty in spelling from memory (no-tech), low-tech options such as personal word lists or portable dictionaries may be helpful. High-tech solutions such as electronic spelling checkers should be considered only after other options have proved less satisfactory because of dependency on batteries, fragility, and so on.

Two common approaches for technology use by individuals with disabilities involve remediation and compensation (Jumani, Rahman, Dilpazir, Chishti, Chaudry, & Malik, 2011; Kouba & Newberry, 2010). **Remediation** involves helping an individual learn or improve performance, often the focus of education, training, and therapy. A graphic organizer to help individuals with learning disabilities improve cognitive processing by visualizing concepts and connections would be an example of technology used for remediation. **Compensation** focuses on using technology to accommodate difficulties performing specific tasks. For example, providing speech recognition software to students with physical disabilities that limit their use of a pencil or a keyboard may help them improve their writing fluency by translating speech to a text format (Garrett, Heller, Fowler, Alberto, Fredrick, & O'Rourke, 2011). Both of these approaches can be used when integrating technology into instruction or therapy.

## General Integration Strategies for All Students

All of the technology integration strategies discussed in this text have important applications for students with disabilities. However, an essential consideration for all educators when planning for the needs of students with disabilities involves ensuring that the curriculum is accessible. When technology is used to make the curriculum accessible, students with disabilities have the same opportunities to learn as their peers without disabilities (King-Sears, Swanson, & Mainzer, 2011; Seo & Woo, 2010). Smith and Okolo (2010) argue that technology is underutilized for students with disabilities, yet these learners stand to benefit most from technological affordances. As technology continues to evolve, it holds great potential for the flexible instructional support necessary for meeting the evolving learning needs of students with disabilities. In fact, research conducted by Wehmeyer, Palmer, Williams-Diehm, Shogren, Davies, and Stock (2011) suggests that technology-supported curriculum in special needs classrooms may lead to increased

student involvement and enhanced self-determination. Because some applications of technology in special education are commonly associated with specific disabilities, the following information will provide a brief overview of specific examples of technology used by people with disabilities.

## Strategies for Students with Cognitive Disabilities

A variety of conditions may impair an individual's cognitive abilities. Such disabilities are often referred to as cognitive disabilities, developmental disabilities, or mental retardation.

**Mild Cognitive Disabilities.** Mild disabilities are considered to be the most prevalent type of disability. They include learning disabilities, serious emotional disabilities, and mental retardation. Meese (2001) describes the following characteristics as being associated with mild disabilities: cognitive (i.e., intellectual ability, attention deficits, memory and thinking skills), academic (i.e., reading, language arts, mathematics), and social-emotional.

Typically, the important issue for these students is not physical access to the technology, but reading, writing, memory, and retention of information. While these students often have some learning difficulties (e.g., the inability to read at grade level), many have difficulty in learning in only one aspect of the curriculum. As a result, educators planning for the needs of students with mild disabilities often use productivity software as well as other software materials and online resources that can be used with many low-performing students (see Technology Integration Example 1). These may include materials for developing reading, writing, and mathematics skills. The key with all of these uses is to balance remediation of skill deficits with activities that help develop more creative, higher level thinking skills.



Learners with cognitive disabilities, developmental disabilities, and/or mental retardation can use assistive technologies to communicate and learn on a daily basis.

© Scott Cunningham/Merrill Education

**Reading skills.** A characteristic associated with many disabilities is difficulty in learning how to read and in developing grade-level reading skills. As a result, special education teachers tend to devote a great deal of time and energy to the teaching of reading and are likely to use a variety of software products to remediate students' reading abilities. Software products such as *JumpStart Kindergarten Reading* (Knowledge Adventure), *Simon Sounds It Out*, and *FastForward* from Scientific Learning are commonly used in classrooms where emergent readers are working on acquiring

specific skills. Interactive storybooks are another commonly used resource. Text-to-speech products that help students with communications disabilities include CAST eReader (CAST), the Quicktionary Reading Pen (WizCom) shown in Figure 3, and numerous mobile apps such as the iPhone and iPad app Speak It! (Future Apps, Inc). If teachers provide all instructional text in a digital format, students with disabilities and other struggling readers will be able to copy and paste the information into talking word processors, apps, and other text-to-speech software programs so that they can listen to information they cannot read.

**Writing skills.** Many tools have been developed to support students who struggle in various phases of the writing process. For students who are unable to write by hand, who have illegible handwriting, or who find handwriting extremely tedious, voice recognition software such as Dragon Talk's *Dragon Naturally Speaking* and numerous mobile apps such as *Vlingo* (vlingo corporation) may be an option. Some students who are slow typists or have difficulty spelling can benefit from word prediction software such as Renaissance Learning's *NEO Writer*, which offers word choices to complete the first few letters the student types (see the example in Figure 4). Also, talking word processors, such as Don

## TECHNOLOGY INTEGRATION EXAMPLE 1

### USING ASSISTIVE TECHNOLOGY TO HELP STUDENTS ACCESS LEARNING MATERIALS

**TITLE:** The Kurzweil 3000

**CONTENT AREA/TOPIC:** Language arts, reading

**GRADE LEVELS:** K–2

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Communication and Collaboration: Collaborate with others; Information, Media, and Technology Skills: Access and evaluate information; Social and cross-cultural skills: Work effectively in diverse teams

**DESCRIPTION:** The Kurzweil 3000™ is a text reader with many built-in features, all of which are designed to support struggling readers. For example, words can be highlighted in context as they are read aloud for the student. Words that students are typing can also be read aloud, and the program supports reading in several languages. Language tools like a multi-language dictionary, thesaurus, syllabification, and phonetic spelling provide additional support. Use this tool for students with learning disabilities to help them focus better on what they are reading and writing, and with students who have visual impairments to give them auditory access to reading and writing activities. Because Kurzweil allows students with special needs to work independently, it builds their confidence. Instead of investing time and effort on decoding words, students will put their energy on solving problems that require higher-order thinking.

**Source:** Based on concepts from Barbara Green and Joan Thormann's "Testing Kurzweil 3000," in the March/April, 2009 issue of *Learning and Leading with Technology* ([http://www.learningandleading-digital.com/learning\\_leading/200904?pg=34#pg34](http://www.learningandleading-digital.com/learning_leading/200904?pg=34#pg34)).

**FIGURE 3** Quicktionary Reading Pen



Source: Courtesy of WizCom Technologies, Inc.

**FIGURE 4** NEO Writer



Source: Courtesy of WizCom Technologies, Inc.

Johnston's *Write:OutLoud*, feature speech synthesis to allow students to hear what they have written.

**Math skills.** Calculators are an important intervention for students with disabilities. A specialized calculator, the Coin-U-Lator® (PCI Education) was developed to assist students having difficulty counting coins and making change. Other strategies have been developed around simple graphing software materials, as well as drills, games, and tutorials. Again, there are numerous mobile apps that are available to assist learners with math skills. Apps such as *Math* (fishdog.net) and *Math Racer* (i4software) allow learners to acquire math skills more easily.

**Moderate and Severe Cognitive Disabilities.** For individuals with moderate and severe cognitive disabilities, considerable effort is devoted to ensuring that they acquire daily living skills such as personal hygiene, shopping, and use of public transportation. In addition, software is available to help teach important functional skills such as money and time management. For example, the *Time, Money, & Fractions On-Track* iPad app (School Zone Publishing) allows learners to acquire skills for managing money and time (see Technology Integration Example 2).

Teachers working with students with moderate and severe cognitive disabilities need to be familiar with an array of devices that provide an alternative means for accessing the computer or mobile device since the typical keyboard may be problematic for many students. To simplify the physical or cognitive demands of interacting with the computer, **alternative keyboards**, such as the Intellikeys keyboard (Intellitools), can be used to create customized keyboards. For instance, keys can be enlarged to provide more space for the student to press a key; keys that are not relevant for a given software program can be removed; and multistep functions such as save, print, or quit can be programmed into a single key press. Companies such as AbleNet assist teachers in integrating the assistive technology into instruction.

## Strategies for Students with Physical Disabilities

Physical disabilities typically affect a person's mobility and agility. Difficulties with motor movements may involve gross- or fine-motor movement and frequently exist concurrently with other disabilities. Assistive technology for individuals with severe physical disabilities may take the form of a power wheelchair operated by a **joystick**, a device with a handle that moves in all directions. Joysticks can also control the movement of the cursor or pointer on a computer screen. To provide access to a computer, it is often necessary to offer an alternative to the typical keyboard. **Switches** are

## TECHNOLOGY INTEGRATION EXAMPLE 2

### USING A WEB-BASED MULTISENSORY ORGANIZER TO HELP STUDENTS WITH SPECIAL NEEDS

**TITLE:** Collecting and Analyzing Data

**CONTENT AREA/TOPIC:** Science, Literacy

**GRADE LEVELS:** K-1

**NETS FOR STUDENTS:** Standard 3—Research and Information Fluency; Standard 4—Critical Thinking, Problem Solving, and Decision Making; Standard 6—Technology Operations and Concepts

**21ST CENTURY SKILLS:** Core subjects: Science. Critical thinking and Problem Solving; Reason effectively; Information, Media, and Technology Skills: Access and evaluate information

**DESCRIPTION:** Using the online Juba site (<http://www.jubalearning.com>), students with special needs can explore, collect, and analyze over 2,000 real world photographs and inquiry-based questions. Teachers can have students collect and analyze data, such as organizing photos by color in a Venn diagram or sorting photos of wild animals and pets. For example, when discussing the difference between living and non-living things, students may search for examples of each and record their own audio summary of each item they have collected. Later they can work on analyzing the pictures and categorizing them into two groups, based on their summaries of features. Juba may also be used to introduce and review the five senses. Students can be guided to locate pictures of people and animals and match each sense to the appropriate part of the body by using virtual drawing tools. All student work is saved to students' portfolio and can be revisited at a later time for further exploration.

**Source:** Sarah McPherson's "Juba," in the February, 2011 issue of *Learning and Leading with Technology* ([http://www.learningandleading-digital.com/learning\\_leading/201102?pg=43#pg43](http://www.learningandleading-digital.com/learning_leading/201102?pg=43#pg43)) and the *Juba Science Lesson Integration Suggestions* ([http://www.sixredmarbles.com/media/docs/standards/Juba\\_SciLessonIntegration\\_MA\\_v1.pdf](http://www.sixredmarbles.com/media/docs/standards/Juba_SciLessonIntegration_MA_v1.pdf))

also commonly used for controlling and getting input to the computer as well as activating environmental control systems.

Assessing the need for assistive technology involves a team of specialists including occupational therapists, physical therapists, rehabilitation engineers, and assistive technology specialists. The goal is to identify appropriate tools for

access and control that will allow the individual to function across environments: home, school, community, and eventually work.

## Strategies for Students with Sensory Disabilities

**Sensory disabilities** involve impairments associated with the loss of hearing or vision. If there is a complete loss of vision, a person is considered blind. An individual is considered partially sighted if there is some visual acuity. Similarly, if there is a complete loss of hearing, a person is considered deaf. Hearing impaired is the term used to describe an individual with some hearing.

**For the blind.** For an individual who is blind, three kinds of technology facilitate independence and access to environments and information:

- » **Canes and sensor technology**—These are used to provide the person with mobility and orientation information when navigating various environments.
- » **Tools to convert printed information**—Other essential tools convert printed information into audio so that a person who is blind can gain information by listening rather than reading. This is accomplished through the use of a scanner, **optical character recognition (OCR)** software to scan and translate print into a word-processed file, and speech synthesis. It works by placing text material on the scanner and scanning the material into the computer. The OCR software then converts the scanned information into text, and the speech synthesis tools read the material aloud. The *Scan and Read Pro* software (Premier Literacy) is a common text-to-speech option used by individuals who are blind. There are also many mobile apps that provide this option such as *TextGrabber* (ABBYY).
- » **Screen readers**—**Screen readers** work as utility software, operating in the background of the computer operating system and reading any text that appears on the screen—for example, menus, text, or web pages. Examples of screen readers include *SuperNova Screen Reader* (Dolphin Computer Access) and *JAWS* for Windows (Freedom Scientific).

**For the partially sighted.** Partially sighted individuals must have text information enlarged, or the contrast altered, in order to perceive printed information. When information is in printed form (e.g., books, magazines, flyers) a **closed-circuit television (CCTV)** magnification system can be used. CCTV is a video camera mounted on a frame with a television monitor. Users place materials on the desktop

below the camera, set the desired magnification level, and move the materials around as necessary such that the information appears on the monitor in a size that can be read comfortably. Many partially sighted individuals can see print on a computer screen by simply activating the built-in screen magnification control panel. This function allows users to select the desired magnification of everything appearing on the screen. This not only helps people with disabilities but also those with failing eyesight associated with aging.

**For the deaf.** Individuals who are deaf often can use most technologies without significant modifications. However, two problematic areas involve the use of audio feedback (i.e., error messages) and the reliance on sound in multimedia software. When designers provide essential information only in audio form, this information is inaccessible to deaf individuals. As a result, advocacy and design initiatives encourage that all information be available in multiple formats (e.g., error messages that produce a message on screen as well as an auditory signal; multimedia software that includes closed captioning of audio tracks).

Individuals with hearing impairments need few modifications to be able to use computers. However, a technology that is being used in classrooms today is **FM amplification systems** (Lewis, 2010). These systems, also referred to as assistive listening devices, involve the teacher wearing a wireless microphone and students with hearing impairments and some students with learning disabilities involving auditory processing difficulties wearing receivers that amplify the teacher's voice and serve to focus attention. Research suggests that sound amplification technology may benefit all students, not just those with diagnosed hearing impairments, by focusing attention. In a study conducted by Millett and Purcell (2010) in which classrooms were equipped with sound field amplification systems and a teacher-worn transmitter, teachers reported higher levels of student attentiveness, a decreased need for repetition, and fewer classroom management challenges. In active classrooms in which noise levels tend to rise, all students benefit from being able to listen and hear more effectively. The Top Ten feature showcases ten great ways for integrating technology in special education.

## Strategies for At-Risk Students

Students at risk for school failure are not considered disabled in the sense of the federal definition of disability. However, their lack of success in school often parallels the low performance of students with disabilities. The use of assistive technology by students with disabilities has helped the profession understand the types of academic challenges students face and the kinds of technology tools that allow them to be





# TOP TEN

## Strategies for Special Education Instruction

Take advantage of these ten strategies for using technology to enhance education for students with special needs in the following categories.

SOURCE	TRACK	SELECTION
<b>Students with Physical Disabilities</b>		
Use alternative keyboards such as IntelliTools' IntelliKeys	<b>1</b>	Students with limited manual dexterity need alternatives to the standard keyboard that let them use the computer independently.
Use joysticks or switches instead of keyboards	<b>2</b>	Students with severe physical disabilities need ways other than a keyboard to get input to the computer.
Use voice recognition software such as DragonTalk's <i>Dragon Naturally Speaking</i>	<b>3</b>	Students who are unable to write by hand, who have illegible handwriting, or who find handwriting extremely tedious can use this software to create text from their speech.
<b>Students with Sensory Disabilities</b>		
Use text-to-speech readers such as JAWS for Windows	<b>4</b>	Students with visual disabilities can use these to have text read to them from a computer screen.
Use optical character recognition (OCR) software or CCTV	<b>5</b>	This strategy helps enlarge text for students who are partially sighted.
<b>Students with Communication Difficulties</b>		
Use text-to-speech products such as WizCom's Quicktionary pen	<b>6</b>	These devices and materials assist students who have difficulty speaking.
Provide a range of tools to support student writers	<b>7</b>	Some students need simplified word processing tools such as Tom Snyder's <i>Scholastic Key</i> , or specialized word prediction word processors such as Don Johnston's <i>Co:Writer</i> .
Use talking word processors such as Don Johnston's <i>Write:OutLoud</i>	<b>8</b>	Provides speech synthesis to allow students to hear what they have written.
<b>Students with Cognitive Disabilities</b>		
Use digital cameras to capture images of objects and environments	<b>9</b>	Students with cognitive disabilities sometimes need concrete examples as cues and prompts for learning.
Use specialized calculators such as Programming Concepts' Coin-U-Lator®	<b>10</b>	These handheld devices help students learn numerical concepts like making change.



**TABLE 2** Matching Technology Resources to the Needs of At-Risk Students

Learning Difficulties	Strategies
Difficulty remembering things to do, sequence of tasks	<ul style="list-style-type: none"> <li>• Provide a reminder service: <a href="http://www.iping.com">http://www.iping.com</a>.</li> <li>• Use a specialized prompting device: <i>Job Coach</i> at <a href="http://www.attainmentcompany.com">http://www.attainmentcompany.com</a>.</li> </ul>
Inability to read and comprehend at grade level	<ul style="list-style-type: none"> <li>• Provide digital text in a text-to-speech program: <i>ReadPlease</i> at <a href="http://www.readplease.com">http://www.readplease.com</a>.</li> <li>• Provide instructional materials with multiple levels: <a href="http://www.windows.ucar.edu">http://www.windows.ucar.edu</a>.</li> </ul>
Difficulties in written expression	<ul style="list-style-type: none"> <li>• Use a predictive word processor, e.g., <i>Co:Writer</i> (<a href="http://www.donjohnston.com">http://www.donjohnston.com</a>) or <i>WordQ</i> (<a href="http://www.wordq.com">http://www.wordq.com</a>)</li> <li>• Offer support for dictation: <a href="http://www.idictate.com">http://www.idictate.com</a></li> </ul>
Difficulties in math computations and concepts	<ul style="list-style-type: none"> <li>• Use online calculators: <i>WebMath</i> at <a href="http://www.webmath.com">http://www.webmath.com</a></li> <li>• Use teaching tools such as Virtual Math Manipulatives at <a href="http://nlvm.usu.edu/en/nav/vlibrary.html">http://nlvm.usu.edu/en/nav/vlibrary.html</a>.</li> </ul>
Lack of motivation to engage in school work	<ul style="list-style-type: none"> <li>• Shift power and control for the student to take responsibility, e.g., clipping services like <i>Crayon</i> (<a href="http://crayon.net">http://crayon.net</a>) to create their own newspaper or <i>My Yahoo</i> (<a href="http://my.yahoo.com">http://my.yahoo.com</a>) to manage a personal calendar and to-do list</li> <li>• Use <i>TrackStar</i> (<a href="http://trackstar.4teachers.org">http://trackstar.4teachers.org</a>) to organize engaging instructional activities that parallel the curriculum</li> </ul>

successful. The impact of the NCLB Act may cause the profession to consider the application of these tools for other students who struggle to achieve in school. Table 2 shows how selected assistive and instructional technology products can match the various needs of at-risk students.

## Strategies for Students with Gifts and Talents

The federal definition of gifted students was developed in the 1972 *Marland Report to Congress*, and has been modified several times since then. The current definition reads:

Students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities (No Child Left Behind Act of 2001, Title IX, Part A, Section 9101(22); U.S. Department of Education, 2004).

The primary issue surrounding and shaping education for gifted students is how to identify students who merit these

special services or activities that they would normally not receive in school. Pyryt (2009) discussed how technology can be used to develop the potential of intellectually gifted students. He elaborated on his model for assisting gifted students in the regular classroom. The approach, called Pyryt's P's, focuses on five P's: pace, process, passion, product, and peer.

- » **Pace**—There are numerous ways content acceleration can accommodate gifted students at an appropriate pace. Content acceleration is possible through diagnostic testing followed by prescriptive instruction (DT-PI). Subject-matter acceleration is now available for students through numerous face-to-face and online courses in content areas such as math from The John Hopkins University.
- » **Process**—Allowing gifted students to develop the ultimate potential of their process skills is necessary. These skills, such as creative thinking, are encouraged through brainstorming techniques and problem-solving approaches. There are numerous websites that assist in this development, such as The Creativity Web, the Center for Creative Learning (<http://www.creativelearning.com>), and numerous distance-learning opportunities, such as Destination Imagination (<http://www.destinationimagination.org>).

**FIGURE 5 Alien Rescue**

Source: Reprinted by permission of the Instructional Technology Program at the University of Texas-Austin.

- » **Passion**—Gifted students have the opportunity to follow their passion when they are given the freedom to think for themselves, producing original knowledge as a professional. This can be done by using simple technologies such as conducting research on the Internet or problem-based learning environments such as *GeoThentic* (<http://lt.umn.edu/geothentic>) and *Alien Rescue* (<http://alienrescue.edb.utexas.edu>) (see Figure 5).
- » **Products**—Allowing gifted students multiple ways to showcase their knowledge through products is necessary. There are numerous ways to accomplish this with technology ranging from podcasts to multimedia projects to documenting dramatization with technology.
- » **Peers**—Being a gifted student does not guarantee peer relationships. Thus, students should be encouraged to use technology to broaden social opportunities. This can range from simple email to wikis to social networking option.

## TECH-PACK NEEDS AND CHALLENGES IN SPECIAL EDUCATION

Teachers who have sufficient special education Tech-PACK are not only well-acquainted with the content and standards of the topics they must teach and the

pedagogical strategies for teaching this content, they also must think automatically of the technologies that will help them carry out effective lessons to teach the content. In special education, a teacher is incorporating the Tech-PACK when he or she reviews a lesson plan and, without hesitation, thinks about the pedagogy and technology that can be used to meet the unique needs of each student in his or her caseload and what adaptations might need to be made to that pedagogy and technology. For example, when reviewing a language arts lesson plan, a special education teacher using the Tech-PACK perspective thinks about technology and how his or her students can learn and achieve content in a way they could not without the technology and relevant adaptations. Thus, a teacher thinks about how he or she can use software products like *AbleNet* (<http://www.ablenetinc.com>), *Simon Sounds It Out*, and *FastForward* from Scientific Learning to provide remedial reading help and also considers voice recognition software to allow students who are unable or who have difficulty writing by hand to express themselves in written form.

A teacher thinks about the relative advantage of having students use this real-time authentic data and uses various pedagogical approaches to scaffold learners to answer difficult questions. To scaffold learners, the teacher must integrate content knowledge, pedagogical knowledge, and technological knowledge to move students to the next level.

## Special Education Content Knowledge

The field of special education presents a unique array of special obstacles related to teachers' content knowledge. First, unlike other content areas such as history and art, special education entails understanding content that relates to public law, technology options, and adaptations. Second, another characteristic of special education that presents special problems is the rapidity with which the content changes. Teachers who were well prepared to be a special education teacher even five years ago have had to keep up with the changing laws, caseload options, and technology or they quickly find their content knowledge out-of-date. Choosing the best materials and technology tools to support instruction for their area means they must also constantly keep updated on their content knowledge so they can identify up-to-date, accurate resources. Keeping updated means attending numerous professional development opportunities, attending conferences, and personal research.

## Special Education Pedagogical Knowledge

Since pedagogical knowledge is often specific to the content area, teachers also frequently struggle to create best strategies to teach topics that may be somewhat or largely unfamiliar to them. Special education instructors face special pedagogical challenges. For example, even when a teacher is aware of all the latest technologies, public laws, caseloads, and content, they still need to know the correct pedagogy to be used within the classroom to assist the learner. All these strategies may be supported and facilitated with technologies, but teachers first must be aware of the basic pedagogies associated with best practice for each special education topic.

## Special Education Technology Knowledge

The use of technology within special education has the potential to transform the learners' experiences. Teachers need to acquire technological knowledge to allow students to learn with and from technology. Teachers need to know about the technology and how to use the technology that affords learning specific concepts and strategies within their classroom. Within any content area, the technology knowledge is many times content and surely pedagogically specific. For example, within special education, teachers need to know all of the technologies that are available for them to integrate within their classroom and, just as important, they need to know how to effectively integrate these technologies within their classroom. In special education, this could mean knowing what the Kurzweil 3000 entails and how to use this technology within the classroom.

Teachers also need to “know what they don't know” regarding technology in their content area. Research is required to acquire this knowledge along with time and professional development to understand the procedural knowledge of using the technology.

## Strategies for Improving Special Education Tech-PACK

Strategies for improving Tech-PACK vary a great deal and there is not one perfect approach for every teacher. After reflecting on their Tech-PACK, teachers must seek out opportunities to help them move their self-identified Tech-PACK to the optimal zone: the intersection of knowledge of all three components (content, pedagogy, and technology). Each teacher should consider the following questions and activities.

- » **Do I have the content knowledge needed to assist my students in meeting the standards within my classroom?** If a teacher does not have the necessary content knowledge, they may consider attending additional special education university courses, attending local special education workshops, attending professional conferences (find a list of conferences at the National Association of Special Education Teachers website at <http://www.naset.org>), and/or working with a mentor who can assist in the knowledge development.
- » **Do I have the technological knowledge needed to teach the special education content within my classroom?** One of the struggles with technological knowledge is that there are so many technologies that teachers need to be constantly aware of as options for their teaching and technology learning take a great deal of time. Teachers need to be motivated to find these technologies, have the confidence to learn them, and then ultimately, use them in their classroom. Learning and teaching with technology can be fun and rewarding, but it does take time. Teachers need to take this time and schools need to provide the professional development opportunities.
- » **Do I have the pedagogical knowledge needed to teach the special education content within my classroom?** Teachers need to be able to take their content and technology knowledge, meld them together, and be able to draw from multiple pedagogical models based on their classroom context to teach their students. For teachers to improve their pedagogical knowledge, they need to be given the opportunity to work with a mentor who has the content and technology knowledge, attend professional development opportunities, and be given the “license to fail.” What is meant by a license to fail is that administrators need to allow teachers to try new technological and pedagogical approaches, even when it is not always successful. If teachers are not given the opportunity to try new and innovative approaches, progress and advancement will not occur.

As part of the end of chapter materials, we are asking you to deconstruct a teacher's Tech-PACK based on what you know of their knowledge and what must be learned to teach special education effectively. In addition, you will look at the context and logistical issues that impact the implementation of Tech-PACK. As you work through this Tech-PACK deconstruction, make sure to reflect on what you would want in your own Tech-PACK and what you believe needs to happen for you to move to the Tech-PACK zone.



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# SUMMARY

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

## 1. Introduction to Special Education

- » Education for students with special needs encompasses strategies for both those with physical and/or mental disabilities and those with special gifts or talents. Regardless of the specific application of technology, the general goal is always the same: to harness the potential of technology in ways that offer an individual with a disability increased opportunities for learning, productivity, and independence.

## 2. Issues and Problems in Special Education

- » Laws and policies govern special education more than other areas of education. This means that teachers, administrators, and special education technology specialists must be well-versed in federal and state laws, policies, and procedures.
- » Issues in special education include: the increase in the number of children with autism receiving special education and other services; American Sign Language (ASL) being recognized as a world language and as a result, e-assessment environments being developed; and universal design emerging from our understanding of the design of physical environments for individuals with disabilities.

## 3. Technology Integration Strategies for Special Education

- » Special educators must be concerned with two types of technology: assistive technology and instructional technology.

Two common approaches for technology use by individuals with disabilities involve remediation and compensation.

- » A variety of conditions may impair an individual's cognitive abilities. Such disabilities are often referred to as cognitive disabilities, developmental disabilities, or mental retardation. There are numerous technologies that assist with these conditions such as the Quicktionary reading pen and Coin-U-Lator.
- » The primary issue surrounding and shaping education for gifted students is how to identify students who merit these special services or activities that they would normally not receive in school. The approach, called Pyryt's P's, focuses on five P's: pace, process, passion, product, and peer.

## 4. Tech-PACK Needs and Challenges in Special Education

- » Teachers who have sufficient special education Tech-PACK are not only well-acquainted with the content and standards of the topics they must teach and the pedagogical strategies for teaching this content, but they also must think automatically of the technologies that will help them carry out effective lessons to teach the content. In special education, a teacher is incorporating the Tech-PACK when he or she reviews a lesson plan and, without hesitation, thinks about the pedagogy and technology that can be used to meet the unique needs of each student in his or her caseload and what adaptations might need to be made to that pedagogy and technology.



# 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.** Ms. Cinqela has a student with cerebral palsy who cannot control her hands enough to write or use a computer keyboard. Ms. Cinqela believes her student is bright; she contributes some valuable things verbally and seems interested in everything the class does. However, she is unable to complete most class assignments. What technology-based strategies could Ms. Cinqela use to address these needs? What would be the relative advantages of using these strategies? Should Ms. Cinqela have her student with cerebral palsy work alone or with other students? Explain your answer.

**2.** Mr. Allgood is a science teacher who has been assigned to teach a group of gifted students. The principal asked Mr. Allgood to create learning activities that would challenge and motivate these students to learn science and mathematics and offer a way they each could demonstrate individual learning using particular kinds of intelligence. What technology-based strategy could Mr. Allgood use to carry out such a project? What would be the relative advantage of using this strategy? Describe how Mr. Allgood might manage this kind of activity in a classroom.

**3.** Mr. Bartle is a fifth-grade teacher who has three low-achieving students with very low mathematics test scores. It is clear that

they each lack basic skills in math facts and operations. Mr. Bartle has no time to work with each of these students individually, but he knows they need practice in the skills they lack. They also need motivation to practice the skills, since each has failed frequently in previous classes. What technology-based strategy could Mr. Bartle use to address these needs? What would be the relative advantage of using this strategy? Should these students work individually, in pairs, or as a small group on this activity? Explain your answer.

**4.** Mr. Tindel is a seventh-grade social studies teacher who has two students with learning disabilities. Neither student can read or write very well. However, both have talents—one is an avid photographer, and the other likes to draw and paint. Mr. Tindel wants to create an activity that allows them to participate fully in classroom projects and to have their talents recognized. He feels this recognition would help motivate them to spend time on other learning activities. What technology-based strategy could Mr. Tindel use to address this need? What would be the relative advantage of using this strategy? How could Mr. Tindel determine whether these two students felt more positive about other class work as a result of participation in this activity?

# TECHNOLOGY INTEGRATION WORKSHOP

## 1. FOR YOUR TEACHING PORTFOLIO

For some of the exercises and activities you do here, you will create products you can add to your Teaching Portfolio. You can add:

- » Lesson plan you create in your Technology Integration Lesson Planning exercises
- » Artifact you create from one of the Project-Based Assignments on the MyEducationlab for your course.

## 2. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 1—EVALUATING AND CREATING LESSON PLANS

Complete the following exercise using the sample lesson plans found on LessonPlans.com, Internet4classrooms.com, educationworld.com, or any lesson planning site that you find on the Internet.

- Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
  - » Wikis
  - » Blogs
  - » Social networking sites
  - » Internet searching
  - » Distance education
  - » Videoconferencing
  - » Internet research
  - » Internet navigation
- Evaluate the lessons—Use the Evaluation Checklist for a Technology-Integrated Lesson to evaluate each of your lessons. An example one can be found at [http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume\\_medialib/IAF13.pdf](http://wps.prenhall.com/wps/media/objects/2448/2507611/Volume_medialib/IAF13.pdf).
- Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies.

## 3. TECHNOLOGY INTEGRATION LESSON PLANNING: PART 2—IMPLEMENTING THE TIP MODEL

Review how to implement the TIP Model in your classroom by doing the following activities with the lesson you created in the Technology Integration Lesson Planning exercise above.

- Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
  - » What is the relative advantage of using the technology(ies) in this lesson?
  - » Reflect on, assess, and describe your Tech-PACK for this situation.
- Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
  - » What are the objectives of the lesson plan?
  - » How will you assess your students' accomplishment of the objectives?
  - » What integration strategies are used in this lesson plan?
  - » How would you prepare the learning environment?
- Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: How would you evaluate the success of this lesson in your classroom in order to determine revision needs?
- Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).
- Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

## 4. TECH-PACK IN ACTION: ANALYZE A SCENARIO

Read the following scenario focusing on Tech-PACK situations and analyze it by answering the questions.

*Mr. Johnson has been a special education teacher for two years. Literally from the time he was a child he had an interest in various technologies ranging from software to the latest computers and game technologies. It always seemed that technology came easy for Mr. Johnson, and he was already motivated by what he learned in his college special education courses on how technology can assist special education. In fact, he spent most of the past two summers researching ways technology can assist his students and help him organize his work. Although Mr. Johnson has only been teaching for two years, he feels very comfortable about using technology in his classroom. Mr. Johnson is still behind on some of the latest policies and is always looking for suggestions on how to manage his caseloads. And, although he knows his technology and is learning his content, the question of how to use the technology to meet each of his students' needs is on his mind.*

- a. Deconstruct Mr. Johnson’s Tech-PACK in the following way. Fill in the following matrix to show what he knows and what he will have to learn in terms of content, technologies, and pedagogies in order to be in his Tech-PACK zone in this topic.

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- b. Identify the context and logistical issues in this situation that he must address to implement this new strategy effectively in his classroom.

you teach. Do the following activities to review your Tech-PACK in terms of what you have learned in this chapter.

- a. Identify a good match between a topic you are likely to teach and one of the technologies or strategies you learned about in this chapter. The technology or strategy should have good relative advantage for teaching the topic in your classroom.
- b. Reflect on your Tech-PACK by completing the following matrix for this topic. Identify what you already know and what you would have to learn in order to implement a lesson using this technology or strategy

Tech-PACK Components	What is known	What must be learned
Technology		
Pedagogy		
Content		

- c. For each of the items in the “What must be learned” column, how would you go about acquiring this knowledge?
- d. Envision and describe the ideal classroom context for teaching your topic using the identified technology.

## 5. WHAT’S YOUR TECH-PACK?: SELF-REFLECTION

For successful technology integration in your classroom context, you need an appropriate combination of technological, pedagogical, and content knowledge (Tech-PACK) for each topic

# 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.



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