# Methods of Education Technology: Principles, Practice, and Tools

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*JEGBERT*

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# Chapter 1 Understanding Classroom Learning and Technology Use

Fun, interesting, engaging, effective, meaningful, crucial, powerful, empowering, real. These are words that teachers want to hear about their instruction. Their goal is to provide instruction that makes a difference in learners' lives. Technology is a powerful resource that is helping many teachers meet this goal. The purpose of this text is to help you meet this goal by addressing what you should know and be able to do with technology. Unlike most technology education texts, the focus of this text is on learners and learning rather than only on the technology itself. This focus will help you to address problems with learning as they arise, integrate new technologies with ease in pedagogically sound ways, and share your knowledge and understandings with your colleagues and students.

Technology should be seen as support for what teachers know and do. Instead of providing a prescription for how to teach, viewing technology as a support for teaching and learning allows teachers to discover ways to do what they already do more efficiently, more effectively, more interestingly, or in new and innovative ways. From this point of view, this text focuses on foundational, or essential, ideas for effective technology-enhanced learning and teaching.

This first chapter provides a foundation for the rest of this text by demonstrating and explaining why you should employ a learning focus to plan technology use and how such a focus might help you effectively meet content and technology standards to address the needs of all learners.

**Preview**

Views of technology use in education have changed steadily and rapidly over the past twenty years. The initial focus was on students learning to use technology. That changed to using technology to learn, as demonstrated by the 2007 International Society for Technology in Education standards for students in Figure 1.1.

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**The ISTE® National Educational Technology Standards and Performance Indicators for Students (revised June 2007)**

1. Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
2. 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.
3. Students apply digital tools to gather, evaluate, and use information.
4. Students use critical thinking skills to plan and conduct research, manage projects, solve problems

and make informed decisions using appropriate digital tools and resources.
5. Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
6. Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

Figure 1.1 2007 NETS for Students

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Compare the 2007 standards to those from 2016, listed below. According to the standards for students, learners should use technology to become:

1. Empowered learners
2. Digital citizens
3. Knowledge constructors
4. Innovative designers
5. Computational thinkers
6. Creative communicators
7. Global collaborators

(Available on line at https://www.iste.org/standards/standards/for-students).

These standards show that the movement in education technology is away from a focus on specific hardware and software and toward what we want learners to be able to do and become; in this way, technology use supports and can be integrated with standards from across the disciplines.

**Meeting the Standards: 21st Century Skills**

Standards, instructional goals, curricula, legislation, teacher beliefs, student experience, resources, and many other variables guide technology use in classrooms. Ultimately educational stakeholders agree that the use of technology is to prepare students, but there is often little agreement on what they are being prepared for (jobs? citizenry? life in general?) and how that preparation should be conducted (drill? experiential learning? discovery?). Nonetheless, for teachers looking to understand what is essential to support learning with technology, the common components integrated into national technology and content area standards and state requirements provide a good start. These goals, often termed “21st-century skills” because of their perceived need in the near future, include:

- Content learning
- Critical thinking
- Communication

- Problem-solving
- Production
- Creativity

Other chapters in this text discuss how to meet these learning goals and how technology can support the process. Find links to your state and disciplinary standards online by searching "+state name +standards" or "+discipline name +standards"; for example, "Idaho standards" or "science standards."

## OVERVIEW OF LEARNING AND TECHNOLOGY

In each chapter of this text, the overview section presents definitions, explanations, and examples of the chapter focus. The discussion then gives readers a consistent understanding of the ideas to be presented and grounds the information in the rest of the chapter. In the current chapter, the overview focuses on a basic understanding of learning and technology.

### What Is Learning?

This text discusses learning before it addresses technology because the central focus of technology use should be what students learn. The concept of learning is discussed in more detail in chapter 2, but clearly there are many ways to understand what it is and how it happens. Many learning theories exist. For example, two currently popular theories include:

Constructivist Theory (J. Bruner)

A major theme in Bruner's theoretical framework is that learning is an active process in which learners construct new ideas or concepts based on their current/past knowledge.

Experiential Learning (C. Rogers)

Rogers distinguished two types of learning: cognitive (meaningless) and experiential (significant). The former corresponds to academic knowledge such as learning vocabulary or multiplication tables, and the latter refers to applied knowledge such as learning about engines in order to repair a car.

For links to other learning theories, conduct a web search for "+"learning theories"."

Many technology texts focus on one learning theory or philosophy as a guide for technology use; however, good teachers follow all kinds of philosophies, and good teaching is not necessarily a matter of behaviorism vs. constructivism or any other "-ism" (Ketterer, 2007). Good teachers keep students engaged and challenged and work with both language and content to develop student skills, abilities, knowledge, and experience (Aaronsohn, 2003). Obviously, this can happen in any number of ways, depending on students, context, goals, and tools. Sometimes it calls for a more behavioristic approach and sometimes for a more cognitive or social approach to teaching and learning. This text points out that whether teachers believe that knowledge is to be memorized or that it is constructed through social interaction, there are ways that technology can help, from providing resources for content learning to supporting independent thought.

To illustrate this and other points throughout the text, each chapter includes a feature titled From the Classroom. This feature integrates ideas, suggestions, and opinions from classroom teachers about the topics in the chapter; they can be found at the end of each chapter. Also, note Figure 1.2 below, which

defines terms that are used often throughout this text in the discussions of learning goals.

**What Is Technology?**

- As with the word learning, the term "technology" has many definitions. According to a variety of sources, technology is:
- Mechanisms for distributing messages, including postal systems, radio and television broadcasting companies, telephone, satellite and computer networks.
  www1.worldbank.org/disted/glossary.html
- Electronic media (such as video, computers, or lasers) used as tools to create, learn, explain, document, analyze, or present dance.

www.openc.k12.or.us/start/dance/glosd.html

- The application of knowledge to meet the goals, goods, and services desired by people.
- The set of tools, both hardware (physical) and software, that help us act and think better. Technology includes all the objects from pencil and paper to the latest electronic gadget. Electronic and computer technology help us share information and knowledge quickly and efficiently.The application of scientific or other organized knowledge—including any tool, technique, product, process, method, organization or system—to practical tasks.

www.nlm.nih.gov/

In general, a broad definition of technology ranges from mechanical assembly lines to Nintendo, from drugs to knowledge. In an even more global sense, technology is seen as a "driver of change" and "the fundamental cause for social shifts toward globalization and the new economy" (NCREL, 2004, p. 1). Technologies of all kinds hold an important place in society, and it is natural that education has been and will continue to be affected by technology uses.

**What Is Educational Technology?**

Educational technology is a subset of all existing technologies. To many educators, the term "educational technology" is synonymous with computers. Although the major focus of this text and of the field of educational technology is on computers, teachers and students use many other technologies in the course of a day, including the pencil, the telephone, and the stapler. Most teachers, however, do not need lessons on how to use a pencil well, so this text follows the trend to define educational technology as electronic technologies with an emphasis on computing. Basic components of technology include hardware, software, and connection, discussed later in this chapter.

**Assessment:** Assessment means gathering evidence about student needs, skills, abilities, experience, and performance. Assessment happens in technology-enhanced classrooms in many ways, as described in each of the upcoming chapters.

**Context:** Context is the environment or circumstances that surround something. For example, if a student poses a problem to be solved, it must be put into context by describing the events that led to it, what features it has, who is involved, and so on. The case at the start of each chapter in this book helps to provide a context for the discussions and examples.

**Effective:** In essence, effective means the capability to achieve a goal. In other words, if a technology-enhanced task is effective, it has the potential and means to help students reach the learning goal. In this text, a crucial element for tasks is that they are effective.

**Engagement:** When students are engaged, they are motivated and find the task meaningful. Engagement can be evidenced by willingness to stay on task, progress toward task goals, and ability to apply task content to life. According to McKenzie (1998), we can judge our classrooms "engaged" when we witness the following indicators:

- Children are engaged in authentic and multidisciplinary tasks.
- Students participate in interactive learning.
- Students work collaboratively.
- Students learn through exploration.
- Students are responsible for their learning.
- Students are strategic.

**Evaluation:** Although many educators equate assessment with evaluation, there are qualitative differences in the terms. While assessment covers a range of processes and focuses, evaluation means making a judgment about something. Typically, this means assigning a grade or other value to whatever is being evaluated. Because schools and teachers have different requirements for evaluation, assessment is given more emphasis in this text.

**Feedback:** Responses to student work, questions, and processes are feedback. Feedback can be positive, negative, clarifying, or interactive, and it can be provided in many forms such as spoken, written, or graphical. Feedback is discussed in every chapter as an essential component of the learning process.

**Goal:** A goal is a general statement about what should happen or what the expected outcomes are. For example, a goal for technology use in science might be for students to understand scientific inquiry. The learning goals presented at the beginning of this chapter serve as the foci for this text.

**Objective:** An objective is a specific statement about what students will be able to do when they complete the task or lesson. For example, for the science goal noted above, objectives could be that students will be able to define "inquiry," to describe each part of the process, and to demonstrate the process. Objectives are usually stated with measurable action verbs—find a thorough list of them at http://www.schoolofed.nova.edu/sso/acad-writing/verbs.htm. Because student outcomes are vital in understanding how to support learning with technology, objectives are mentioned in many chapters.

**Process:** A process is a sequence of events or procedure for accomplishing something. Each chapter in this text describes the process for achieving a learning goal. These processes overlap but each goal also has its own particularities.

**Scaffold:** A scaffold is information, feedback, a tool, or some other form of support that helps students grow from their present level of knowledge, skill, or ability to the next level.

**Figure 1.2 Terms used in this text**

Each type of technology affords opportunities for different actions and can help fulfill learning goals in different ways. For example, students can learn to communicate and write with word processing and email tools; they can learn to organize and analyze with database, spreadsheet, and graphical organizer programs; they can learn about the importance of visuals using drawing software, participating in a virtual fieldtrip, or making a photo collage. Educational technology has been categorized in different ways based on these different goals. It has been looked at as:

- A tutor that presents information to be memorized (e.g., drill-and-practice software, instructional video)
- Support for student exploration (e.g., through electronic encyclopedias, simulations, and hypermedia-based data presentations that students can control)
- A creativity and production tool (e.g., word processing, videotape recording)
- A communications tool (e.g., email, electronic discussion forums)

In 2001, Levin and Bruce defined technology as media for (a) inquiry,(b) communication, (c) construction, and (d) expression. There are many more ways to describe educational technology, but across all of these descriptions, two main ideas emerge. First, as technology changes, so does the uses to which it is put and the ways in which it is characterized. The Internet, for example, has revolutionized the way that many students can obtain and use resources. The second, and seemingly apparent, idea is that a computer by itself is nothing but a plastic box with wires and silicon. In other words, a computer cannot do anything by itself. Ascione, in 2006, noted that what people do with technology is central to what it does for people; this crucial idea underlying technology use has not changed in the past decade and continues to be central to the use of technology in classrooms.

**Technology Effectiveness in Classrooms**

In fact, although widely believed to cause better achievement, technology has not been shown overall to be effective at increasing student achievement. In part, this is because the research on effectiveness is “contradictory and/or seriously flawed” (Burns & Ungerleider, 2002–2003, p. 45). However, that does not mean that technology cannot be used to support student achievement in specific contexts. For example, Burns and Ungerleider (2002–2003) note that when age, task, and autonomy are considered in the use of computers, there are benefits to group work, high-level concept understanding for older students, and improvement in student attitudes toward computer technologies. Chauhan (2017), Cheung & Slavin (2013), and other researchers show that

- Students can learn faster in computer-based instructional contexts.
- Student attitudes toward their classes are more positive when they include computer-based instruction.
- Children with special needs can achieve more in technology-rich environments.
- Students of all ages and levels can achieve more across the curriculum in technology-rich environments.However, Chauhan also notes that for technology to have a positive effect, learning objectives must be clear and the technology must be used for specific, targeted goals. Research also clearly shows that the effectiveness of technology use is based on context—in other words, it depends on factors such as: the learner; the learning environment; the knowledge, experience, and attitude of the teacher; the technology used; the task, and; how technology use it assessed. Most important is that effective teaching and learning drive technology use. Two decades ago, McKenzie (1998) supported this view, noting that "there is no credible evidence that [technologies] improve student reading, math, or thinking skills unless they are in service of carefully crafted learning programs" (p. 2). This continues to be the case.

### What Drives the Use of Educational Technology?

In spite of mixed reports on its effectiveness for learning, technology is used in classrooms across the nation. For some teachers, their interest in doing something innovative drives technology use. For other teachers, obligations imposed by their schools or districts, for example, required lab use, does. Other impetuses include community/parental pressure, student demands, and economic rewards. State and federal laws push technology use by requiring that teachers and students be proficient and demonstrate learning. For example, the 2015 federal Every Student Succeeds Act requires that every student be technology literate, and teachers must be knowledgeable enough to help students reach this goal. Finally, the increase in student excitement, motivation, and achievement that teachers see as a result of technology use is another teacher motivator to use educational technology.

## STUDENTS AND TECHNOLOGY

In addition to the possible benefits listed above, why else do students need to be taught with and about technology? According to Gordon (2001), "Students may perform a Web search faster and better than their teachers, but they still need to be taught to filter and critically engage with what they read, see, and hear from the multimedia devices they so deftly operate. And school is still the place where they will need to develop the skills they need to function effectively in the world—to read and write, to add and subtract, to understand how nature and societies are organized and where they fit in" (pp. vii–viii). In other words, there are many other reasons why students should study about and with technology. Each chapter in this text presents benefits to students related to the topic of the chapter; some general benefits are presented here.

### Student Benefits from Learning with and About Technology

One of the benefits of students learning with technology is that they will be engaged in new literacies, or new ways of being knowledgeable. Within the learning goals, a number of literacies are becoming more focal because technology calls attention to them. Three main literacies include:

**Information literacy** is the basic ability to "recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information" (American Library Association [ALA], 1998). More recently, the American Association of School Librarians and other organizations have created standards that include the need for lifelong learning and the ability to deal with the ever-increasing number of resources available both online and off (ALA, 2017). Students cannot recognize when information is needed if they do not have a grasp of the information that has already been presented to them. For example, conducting an accurate Web search and finding information that is appropriate and factual is part of being information literate. Information literacy implies that learners also have visual, numerical, computer, and basic (text) literacy. More detail on these standards is available from www.ala.org; also see their list of "Best Apps for Teaching and Learning" at

http://www.ala.org/aasl/standards/best/apps/2016.

**Technological literacy** is a second important but often overlooked literacy; this is the ability for students to be able to make "informed, balanced and comprehensive analysis of the technological influences on their lives and then be able to act on the basis of their analysis" (Saskatchewan Education, n.d., p. 1). In other words, students must understand not only how to use technology, but understand the many ways in which technology affects their lives. Computers are only one of the many technologies that this literacy addresses.

**Media literacy** addresses technology and more as it involves critically thinking about the influences of media (including books, TV, radio, movies, and the Internet). It means choosing, reflecting on, appreciating, responding appropriately to, and producing media of all kinds. For example, media-literate students understand the motivations behind television commercials and can judge the merits of the product despite the persuasive techniques employed by advertisers. A great source for media literacy information is the Media Awareness Network at

http://www.media-awareness.ca/english/.

Clearly, these literacies are tightly linked to the learning goals, and student achievement in these areas provides lifelong benefits. These literacies are integrated, even where not specifically mentioned, throughout the activities and ideas in this text.

Another benefit of student technology use is a change in how learning occurs in classrooms. If we think about how children learn at home and in the world, we can see that there is a disconnect between natural learning and classroom learning. Outside of school, children are encouraged to explore, to inquire, to experiment, and to come to their own conclusions with the help of adults and peers. In classrooms, children are often asked to listen, memorize, and not to question. Technology use can make it more possible for students to learn in ways that resemble natural learning by providing resources, support, and feedback that teachers alone may not be able to pro- vide. Of course, technology will not have these benefits if it is not used in ways that support this vision of learning. As a number of scholars have noted, just because you can do something with technology does not mean that you should. The goal is to make the technology use itself transparent, while examining the interactions, content, and

process of the learning that occurs with technology.

## TEACHERS AND TECHNOLOGY

As a technology-using teacher, you are central to meeting the goals of technology-supported learning. However, 50% of teachers describe themselves as unready to use technology for instruction (U.S. Office of Educational Technology, 2016). To support learning with technology effectively, teachers must learn how to integrate technology into effective learning tasks and understand what their roles are during the technology-supported learning process. Each text chapter provides characteristics of effective learning tasks based specifically on the chapter's learning goal. It also provides insights into teacher roles that effectively support learning with technology.

### Characteristics of Effective Learning Tasks

In general, effective student tasks are those that result in authentic, meaningful, engaged learning. For a technology-supported task to be effective in this sense, it should have these general characteristics:

1. **Focuses on goals.** Goals are developed based on standards, curricular requirements, and student needs, wants, and interests. Each chapter presents examples of goals.
2. **Includes technology that is working and available.** However, it must be more than just some technology, it has to be the right technology. Guidelines to assist in making appropriate technology choices are presented throughout this text.
3. **Includes teacher education and support**. Each chapter describes ways that teachers might find, discover, request, or use training and support.
4. **Allows time to learn relevant technologies**. Guidelines in all the chapters discuss ways to do this efficiently.
5. **Provides needed resources**. Resources include lab time, online and offline information sources, and skills lessons. Suggestions for how and when to provide such resources are presented throughout this text.
6. **Uses technology only if appropriate.** Effective tasks do not use technology if goals can be reached and content can be better learned, presented, and/or assessed through other means and tools. Each chapter includes a section on learning activities that demonstrate appropriate uses of technology.Figure 1.3 summarizes these characteristics.

**An effective technology-enhanced task:**

- Focuses on goals
- Includes relevant technology
- Includes teacher support
- Integrates time to learn
- Provides a variety of relevant resources
- Uses technology only if it is necessary

Figure 1.3 Effective task characteristics.

**Teachers' Roles**

Teachers' roles in classrooms have changed. Although some teachers continue to work within a curriculum in which teaching is central and pencil and paper the norm, the trend is toward goal-centered and student-centered curricula in which student learning, supported by technology, is focal. This focus has changed the teacher's role in the classroom. A student-centered focus that includes understanding and addressing students' interests, for example, means that teachers need to vary their teaching so that student interests are connected to classroom content and tasks; technology use can help teachers to do so. As one saying goes, "While technology will not replace teachers, teachers who use technology will probably replace those who do not." For more information on why technology cannot replace teachers, see Purewal (2016).

**Challenges for Teachers**

Teachers using technology may face environmental, physical, attitudinal and philosophical, access, equity, cultural, financial, legal, and other obstacles. These challenges are presented in every chapter and discussed in depth in chapter 9. One challenge that teachers often voice is the idea that computers will put them out of a job. But there are many things that teachers can do that technology cannot. Figure 1.4 presents a very incomplete list that shows why teachers cannot be replaced by technology.

As important as understanding what technology cannot do is understanding what it can. Figure 1.4 also presents some of the things that technology is typically more efficient or effective at than teachers are. How do teachers help it do this? Teachers can treat technology as the tool that it is and integrate its use into every content area. In addition, instead of teaching one or more technologies as the goal (or, if necessary, in addition to), teachers can employ technology to meet curricular goals in all areas.

Some teachers fear, often rightly, that technology learning may take the place of content learning and that the curriculum will not be covered. Teachers often do not understand at first how to balance technology and content and worry that there is not enough time to learn the technology they need. In these cases, teachers often stop using technology to focus on content, use only one technology repeatedly, or just

**What can't technology do?**

- Design a seating chart, taking into consideration understandings about children and their attitudes toward one another.
- Make friends or show respect.
- Create lessons that address the needs of diverse students.
- Decorate a classroom.
- Choose a textbook.
- Manage 20 third graders.
- Make a decision based on a gut feeling.
- Give creative feedback.

- Understand.
- Search for or create knowledge.
- Teach.

**Technology Can't...**

**What can technology do?**

- Manipulate streams of meaningless data.
- Repeat itself endlessly.
- Help make learning more efficient by controlling large amounts of data quickly.
- Help make learning more effective by providing a great wealth of resources and allowing students choices.
- Operate in environments where humans cannot.
- Connect people who could not connect cheaply or easily otherwise.
- Provide means to improve students' acquisition of basic skills and content knowledge (Kleiman, 2001).
- Motivate students (Kleiman, 2001).
- Work quickly and objectively.
- Strengthen teachers' preferred instructional approaches—for example, those who lecture can use computer-enhanced visual support, those who prefer inquiry-based approaches can use raw data on the Web and databases or spreadsheets for analysis.
- Help to change the vision of a classroom as a room with four walls that depends solely on the teacher for information.

**Technology Can't do...**

Figure 1.4 What technology can and can't do. Jump in and hope for an eventual best. But it does not need to be this way. Support from students and parents, willingness to set aside an hour a week for additional learning, and/or a district that is willing to support grant writing are some of the ways discussed in this text to help teachers find the time they need to learn about technology use. Chapters 8 and 10 address these issues. In addition, the Guidelines section in each chapter supports teachers in understanding the roles of technology in classroom learning and how they might plan their learning about technology.

**GUIDELINES FOR USING EDUCATIONAL TECHNOLOGY**

In each chapter, the Guidelines provide practical suggestions for teachers to help meet learning goals and overcome potential barriers. In this chapter, the guidelines present general issues to help you meet goals for technology use. These guidelines are summarized in Figure 1.5 below.

**Guideline #1: Understand the realities of technology use.** In addition to understanding what technology can and cannot do, there are other significant realities that teachers need to understand. For example, learning to use technology well takes time—for everyone to learn, for effective uses to be

discovered, and for implementation to be complete. Learning technology will not always be smooth, but help is available from members of the school community, including parents, technology specialists, knowledgeable students, and other teachers. In addition, teachers can join online teacher-based groups such as the Global SchoolNet Foundation (http://www.globalschoolnet.org/index.cfm) for help, ideas, and resources.

The special effects of technology such as cool art, stickers, sound effects, and so on (often called "bells and whistles") may take precedence for students over task content at first, but well-designed tasks following the guidelines in this text can help avoid this problem. In addition, there are resources to help with just about every technology need, from using the icons in Microsoft Word (see http://infobitt.blogspot.com/2010/06/toolbars-screentips-and-toolbar-buttons.html) to finding appropriate content for diverse learners (see the Colorín Colorado! site at http://www.colorincolorado.org/teaching-ells/technology-english-language-learners). This text and the accompanying Teacher Toolbox will help you to explore and find additional technology resources by presenting a variety of Web sites, software packages, and support information and by suggesting places to look for further ideas and information. This text will also encourage you to share your findings with other educators.

**Guideline #2: Examine equity and access for your students.** Loschert (2003) reported 15 years ago that, although the average school had over 100 computers, each student typically had only 20 minutes per week on the computer. In addition, girls, minorities, and students with special needs often had less access than other students, particularly in high school (Kleiner & Farris, 2002; Male, 2003). Unfortunately, this trend, while decreasing, still holds (National Center for Education Statistics [NCES], 2015). NCES (2015) notes that 8% of school-age students (5-15 years) still had no Internet access as of 2013. If everyone is to learn with these tools, everyone must be able to access them. Other chapters in this text provide ways to arrange and use technology to make access more equitable; these include making the best use of classroom computers and creating arrangements to share technology equitably and effectively within schools.

**Guideline #3: Consider student differences.** Students bring skills and backgrounds that can add to or detract from technology-enhanced learning experiences. Teachers can assess student needs by first investigating their learning preferences, cultural and language differences, and background experiences and knowledge. Teachers can then address these needs by applying the techniques and strategies presented throughout this and other texts. These techniques include, for example, using content resources at multiple levels, giving students choice in the products they develop, and providing extra support for students who need it. In addition to specific instructional strategies, computer technologies can also help address the needs of diverse students and help to include students with a variety of abilities in classroom tasks. For example, special technologies called assistive devices can help teachers to provide larger text for sight-impaired students, voice recognition for students with physical disabilities, and extra wait time, feedback, or practice for those who need it. Assistive devices are presented later in this chapter and throughout the text. Technology can also provide support for English language learners (ELLs) and other students by providing resources in a variety of languages

and many different ways to work (Egbert, 2005), from supportive team-based software to individual remediation Web sites. Suggestions for supporting the learning of ELLs with technology are noted throughout the text.

| Guideline | Summary |
|---|---|
| #1: Understand the realities of technology use. | Learning to use technology effectively takes time. Give yourself and your students the time. |
| #2: Examine equity and access for your students. | Not all students have equal access to technology. Teachers must make sure that everyone who needs it is given fair opportunities. |
| #3: Consider student differences. | Students who are physically and/or socially challenged or have other barriers to learning must be considered while technology-enhanced instruction is being designed. |

Figure 1.5 Guidelines for the use of educational technology

**TECHNOLOGY-ENHANCED LEARNING ACTIVITIES**

The Learning Activities section in each chapter presents suggestions and examples to use as models to effectively use technology. In this chapter, you will read real-life educational technology uses taken directly from school reports. These examples provide an initial idea of effective ways that technology is being applied in classrooms. The technology uses in the examples below, from the first decade of the 21st century, could still be considered innovative at the end of the second decade; this is one indication not only of how slowly technology uses have made their way into classrooms but also how much teacher professional development in uses of educational technology is still needed so that all teachers can integrate technology effectively, like the teachers below:

> Elaine Insinnia, an eighth-grade language arts teacher from Berkeley Heights, New Jersey, uses Internet research to help her students understand the novels she assigns. Using questions to help focus the students, Insinnia directs them as they research a book's author, the story's time period, and key historical events related to the plot. In the past, Insinnia and her students conducted similar research in the school's library, which often took several class periods. With the Internet, "you can get the same amount of information in 25 to 30 minutes," she says. "It saves you lots of time and the kids pay attention." The project lets students take control of their learning as they explore Web sites and information that interests them, Insinnia says. The project also teaches students how to evaluate the validity of information they find on the Web. After they complete their research, students share their findings in an online chat room [a Web site that allows communication in real time]. "When you are in a classroom discussion, the same kids dominate the discussion," Insinnia says. "In the chat room everyone gets a chance to answer and they are engaged." The chat room discussion also provides a record of each student's contribution, which Insinnia can review later, she adds. (Loschert, 2003, n.p.)

> Tony Vincent, a fifth-grade classroom teacher in Omaha, Nebraska, reports: "Using a computer

program called Sketchy, which functions like a digital flip book, students create short cartoons that show each step they take to solve a math problem. They move the numbers around the screen as they solve a problem and add 'thought bubbles' to explain their work. Students find the programs so engaging that they watch their cartoons, and ones created by their classmates, repeatedly. The process of creating the product and reviewing it reinforces the thought process students should use to solve the problems. … As a result, a lesson that used to take two weeks now takes just three days for students to comprehend." (Loschert, 2003, n.p.)

When Jane McLane first mentioned her upcoming sabbatical to bicycle around the world to Kristi Rennebohm Franz, a fellow teacher at Sunnyside Elementary in Pullman, Washington, she never dreamed she'd end up with 25 virtual companions. But somehow she did—Kristi's first and second graders! By carrying a digital camera and a small computer, Jane was able to communicate on a daily basis with Kristi and her students. Along the way, Kristi's students learned to write, read, and communicate as they interacted with Jane about world languages, cultures, geography, art, time zones, and architecture. (Learning Point Associates, 2004)

In a challenge described by FermiLab LInC (2000), seventh-grade students will be challenged to develop a schoolwide recycling program. The challenge will be for everyone, students, teachers, administrators and especially the cafeteria and lunch program, to recycle waste products. Students will form teams to investigate waste and waste management. They will also contact other schools throughout the country (via email) and collect data on school recycling programs. Do they exist? How are they managed? What percentage of waste has to be hauled away? What are the costs for running such a program? The teams will be encouraged to develop a Total School Recycle Program to either internally handle waste or to find resources that will productively utilize waste products. This will involve investigating the means of disposing or recycling all the waste generated from their school building. Can it be done? (FermiLab LInC, 2000)

All of these examples are adaptable for a variety of grade levels and students and can make use of a variety of different technologies. More importantly, they demonstrate effective task characteristics and focus on 21st- century learning goals such as critical thinking and problem-solving. The technology is employed as support for effective student learning. This learning focus is important because technology changes so rapidly. In fact, even by the time you finish reading this text, much of the technology mentioned in it may be in a new version, may have a new format, or may be obsolete entirely. However, having a firm grounding in the learning goals that will continue to be essential—for example, critical thinking, problem-solving, content, and communication—means that teachers and students will be able to continue to integrate technology, deal with change, and work toward success.

**Technology for Supporting Learning**

Each chapter in this text presents a variety of technologies that can be used to support learning. This first chapter presents a general overview of technology for reference at any time during your reading of the text. It focuses on a basic understanding of educational technology that includes awareness of the components of any tool.

### Components of Electronic Tools

Electronic tools generally consist of **hardware**, **software**, and **connection** components. Table 1.1 presents a basic overview and broad definitions of hardware components listed in alphabetical order. For hardware, the three main types are input, processing, and output. **Input devices** are used to enter information into the computer. **Output devices** display or deliver the information in a format that users can understand. **Processing devices** change the input into output. There are also **communication devices** that connect computers to each other. The components listed in the table will also be mentioned in other chapters in this text.

Software is composed of a set of instructions that controls the operation of a computer. The most important software is the **operating system** or OS. The OS manages the rest of the software on the computer. Typically software is developed for one OS or **platform**, either Macintosh OS or Windows, but some software can run on these and other less common operating systems such as Unix and Linux. Find tutorials for these common operating systems by searching the Web.

Information about types of software, software functions, and parts of a software package is presented in Table 1.2 below. These terms are used throughout this text.

Connection components, some of which are technically hardware (e.g., a modem) and others that are software (e.g., an e-mail package), allow computers around the world to communicate. A short list of important components is presented in Table 1.3 below.

**Table 1.1 Hardware Components**

| Hardware | Function | Uses |
|---|---|---|
| CD-ROM (compact disc, read-only memory) DVD (digital video disc) | Storage device | A portable optical recording device that store massive amounts of data |
| Central processing unit (CPU) | Processing | The “brains” of the computer, the central processing unit contains the motherboard, disk drive, and chips. Loads the operating system to enable the computer to run on and work; performs operations |
| Digital camera | Input device | Entering video and images |
| Flash drive | Storage device | Portable, very small storage devices are also known as thumb drives and USB drives. Flash drives fit in a computer’s USB port–very convenient for storage. |
| Handheld/Mobile device | Combination device | These small computers have almost the same range of uses as their desktop-size counterparts, but they are more portable, cheaper, and wireless. Many people use their cell phones to serve as a device that can receive input, allow for transformation of that input, and output to many other devices. |
| Hard drive | Storage device | Storing information long-term on a computer. The hard drive contains any software installed on the computer and files that the user has created and saved. |
| Keyboard | Input device | Enter text and numbers. Many people currently use voice input, and more will as the software that it employs becomes more accurate. |
| Microphone | Audio input device | Enter audio information, particularly for speech recognition. |
| Modem | Communication device | A device that allows one computer to talk to another over a phone or cable line. Modems are also part of wireless communications. |
| Monitor | Output device | Display information on the computer. |
| Mouse/touch screen/touchpad | Input device | Pointing to and selecting information. Touch screens are becoming the norm as more people use their phones and other mobile devices. Users can input with their fingers or with a special pen called a stylus. |
| Printer | Output device | Print a hard copy of graphics and text on paper or paper product. 3D printers can also print multidimensional figures and are being used across disciplines, although they are not present in the majority of schools yet. |
| Projector | Visual/audio Output device | Provides a bigger picture than a monitor and can broadcast for a group. |
| RAM (Random access memory) /ROM (Read-only memory) | Storage device | RAM is the computer primary memory and store what is currently in use. ROM stores the computer’s instruction set and cannot be changed by the user. |
| Scanner | Input device | Enter drawings, documents, text, and designs or anything else that the user wants a copy of in digital format. |
| Speakers | Output device | Listening to audio output |
| Webcam | Input device | Take pictures to be displayed on the Internet and communication in real-time with other users who can see you. |

**Table 1.2 Software**

| Software | Category | Examples |
|---|---|---|
| Commercial | Software type | Microsoft Office Suite |
| Communications | Software function | Email, courseware (addressed in chapter 3) |
| Freeware | Software type | Programs from sites such as download.com and tucows.com |
| Operating system | Software component | Mac OS, the latest Microsoft Windows version, Linux, and others |
| Personal productivity | Software function | Word processor, database, spreadsheet, presentation software (addressed in chapter 7) |
| Programming software, formatting languages | Software function | C, Java, HTML and many more types that allow users to create instructions for the computer. Children can code a variety of programs with software such as Blockly, Python, Ruby, and Scratch.Find more information by searching these programs on the Internet. |
| Shareware | Software type | Software that users can choose to pay for if they like it, found at sites such as totalshareware.com, bestshareware.net, freshshare.com |
| Teacher tools | Software function | Grade books, letter generators, rubric makers |
| User interface | Software component | The user interface is what the user sees on the screen/monitor. A poorly constructed user interface can make software or a web site hard to use. |

**Table 1.3 Connection Components**

| Connection | Function |
|---|---|
| Internet | Connects computer networks around the world so that they can “talk” to each other. Computers must typically have a modem (see hardware). |
| ISP | Internet Service Providers (ISPs) are organizations that provide connection to the Internet, typically for profit. |
| LAN | Local area networks (LANs) connect computers on the same network through wireless or cable connections to share printers and applications. |
| WAN | Wide area networks connect local computers to a broader network (such as the Internet) or connect LANs together. |
| World Wide Web(WWW or Web) | Part of the Internet that enables electronic communication of text, graphics, audio, and video. |

### Assistive Technologies

This text addresses supporting learning with technology for students with a wide range of abilities, skills, and needs. In some instances, the choice of resource or student role in an activity will be enough to help students access academic content. In other cases, special technologies, called assistive devices, will be needed for students to access the information they need. In general, assistive devices are hardware and software designed for specific needs. Table 1.3 presents examples of some of these devices, and others are presented throughout this text.

300.5 Assistive technology device.
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. The term does not include a medical device that is surgically implanted or the replacement of such device.
https://sites.ed.gov/idea/regs/b/a/300.5

In addition, the Microsoft (www.microsoft.com) and Apple (www.apple.com) Web sites list all of the assistive devices included in their operating systems.

The benefits of access to technology for students with disabilities include:

- Being able to bridge ideas
- Sequential practice to master concepts step by step
- Control over their environment
- Timely feedback
- Access to multimodal (visual, auditory, tactile, and kinesthetic) and multi-intelligence materials (Barry & Wise, n.d.)

Teachers need to understand why and how to use assistive technologies to help students effectively. For example, teachers may not think about how students with different abilities will access information from the Web. For students who are visually impaired or physically challenged, access is an important issue. Simple solutions to access problems range from making the text in the Web browser bigger so that sight-impaired students can see it to providing a special large mouse that needs only a light touch to work. For ways to make the Web more accessible to all students, see www.phschool.com/about_ph/web_ access.html and other parts of this text.

**Table 1.3 Assistive Technologies**

| Device | Function | Sample Uses | Examples |
|---|---|---|---|
| Accessibility testers | Test whether a Web site is as accessible as possible | For all teacher- and student-made Web pages | Bobby software (Watchfire) |
| Closed-captioned TV | Shows the TV audio in text | For students who are hearing-impaired | Every TV sold in the U.S. since 1993 must have closed- captioning capability |
| Touch screen | Students touch the monitor screen to give instructions to the computer, e.g., to click on links. | Can be used instead of a mouse for students who cannot control a mouse well. Touch screens are often used with young children. | Other “mouse emulators” include special keyboards, laser or infrared pointers, keyboard overlays, trackballs, and a variety of devices that can be tailored to students’ needs. |
| Screen magnifiers and screen readers | To make screen text bigger and/or to have the text read aloud | Helps sight-impaired users | Usually part of the operating system on computers; there are also free magnifiers that can be downloaded from Internet sites. |
| Signing avatars | Animated characters who use sign language | For students who use sign language | See the Signing Science Dictionary at http://signsci.terc.edu/ and find out more at the University of Toronto’s Adaptive Technology Resource Centre, http://www.adaptech.org/en/team/atrc (in particular, see the downloads page). |
| Voice recognition software | Turns oral language into text on a computer screen | For students who cannot physically enter data other ways | Dragon Naturally Speaking and IBM’s ViaVoice. |
| Universally designed software | Features include spoken voice, visual highlighting, and document or page navigation. | Makes software accessible to struggling readers and students with disabilities and enables struggling readers to read the same books as their peers. | eReader (CAST; www.cast.org/our-work/learning-tools.html) and Thinking Reader software (Tom Snyder Productions/Scholastic). |

The University of Washington’s DO-IT program provides teachers with outstanding resources such as videos and articles for understanding and working with assistive technologies. Read more about this program on the Web at http://www.washington.edu/doit/.

**Appropriate Tool Use**

Most important to understand in the discussion of technological tools is that if the tool does not make the task more effective or more efficient, a different tool should be employed. In addition, if there is no appropriate digital technology that fits the task, digital technology should not be used. For example, asking first graders to type sentences on the computer might be fun for them, but teachers need to evaluate whether the time students spend hunting for the correct keys and making editing mistakes might be better spent with a pencil or crayons. Or, setting ninth graders free on the Internet to

research famous Americans might result in chaos that could better be organized by employing a more manageable information set in a digital encyclopedia. This theme of principled technology use is repeated throughout the text. The thoughtless use of technology and the problems it causes is well documented and discussed (Aslan & Reigeluth, 2010; Ferneding, 2003; Postman, 1993) and can be avoided.

**ASSESSMENT**

After you have reviewed the goals for your lesson, decided on an effective task, integrated technology in appropriate and effective ways, and supported students through the task process, it's time to assess. Each chapter in this text presents ways to appropriately assess student progress toward learning goals. Most important in the discussions of assessment is that both the product of student learning and the process of student learning are the foci of assessment. In the examples given throughout this text, technology is the focus of assessment (for example, did students use it well? was it appropriate for the task?) and used to assess (for example, an observation checklist on the teacher's handheld computer). However, it is important that assessments fit the specific context and students for whom they are developed. Therefore, note that the assessments in this text only serve as models. They probably cannot be used without at least some adaptations to fit specific classroom, task, and student conditions. For example, a rubric, or detailed scoring outline, that is made to evaluate a technology-supported presentation for fifth graders is most likely inappropriate to evaluate a presentation by 10th-grade students.

The text addresses a number of assessments, including:

- Scoring guides (chapter 2)
- Rubrics (chapter 3)
- Multiple-choice tests (chapter 4)
- Checklists and peer team reports (chapter 5)
- Performance assessments (chapter 6)
- Problem-solving notebooks (chapter 7)
- Electronic portfolios (chapter 8)

These assessments can be used in a variety of contexts other than those described in the chapters. The text's brief theoretical discussions that accompany assessment examples will help you to understand how and when to employ them effectively.

As you move on to the rest of this text, keep in mind the underlying premise of this chapter, that learning comes before technology. Be sure to review ideas in the chapter as needed and to use the glossary of terms and table data to support your learning throughout the text.

**FROM THE CLASSROOM**

Below are comments from teachers that relate to the content of this chapter.

**Theory and Practice**

Our questions and frustrations reminded me of the three main theories which exist… The first is the behaviorist: [learning] is acquired through imitation, direct instruction, practicing through drills, memorization, etc. The second is innatist: [learning] is acquired naturally, just by listening to it and being immersed in an authentic environment. No direct instruction or correction is needed. The last is interactionist, which says that [learning] is acquired naturally, but it stresses the interaction portion, and also says that sometimes it is necessary to teach specific rules or correct student output. These are coming from the experts and it seems to me that perhaps pieces from each are true. I doubt any one theory could ever explain how every unique individual will learn. I think there is a time and a place for flashcards and memorization, but I think it is also crucial to have meaningful interaction. (Jennie, first-grade teacher)

**Learning Focus**

We can't just throw the kids on a computer and expect learning to take place any more than we would show them the text and tell them to learn it by the end of the year. No matter what tools we use, we need to use good teaching practices, or our teaching will be ineffective. (Susan, fifth-grade teacher)

[A reading] says that computers are not capable of teaching, that teachers are the ones who actually perform this. I completely agree with this because it is important to keep in mind as technology continues advancing. This is why I feel that we need to rely on the content of our lessons in incorporating technology rather than using technology just because it will be fun when the activity itself might be better without it. Learning occurs best when it is driven by the human processes, not the technology. When this occurs, students are involved in their learning through negotiation of meaning with one another and are focused on the content of the project. (Cammie, student teacher)

**Teacher Concerns**

I [keep] thinking about "how do I keep up?" I would love to see my students with digital notebooks, me videoconferencing with parents and students, using voice-generated technology. First, district and state will need to support technology growth and use in the classrooms with monies for technical support: training, maintenance, wiring. Second, respect for equipment needs to be taught to students and families (now, if a student misplaces a book, parents may or may not pay). Thirdly, as professionals we (educators) will need to embrace the new technology. I am ready! (Jean, sixth-grade teacher)

**Teachers' Role**

I also wonder how much the role of teachers will change as technology advances. I even applied for a tutoring job with [a company where] you tutor online with a digital pencil and headset! Pretty crazy. Also, if we can listen and learn from history . . . there were so many predictions that new technology would revolutionize teaching and they really never did. For example, when the radio, TV, and mainframe computer came out, they were all expected to change the entire educational scene, but in reality, the changes were minute. From my reading, educational technology researchers always warn not to get overly excited about the future of technology based on history. (Jennie, first-grade teacher)

**Assessment**

I see [the] point about finding the purpose of assessment before deciding what type is more

appropriate. However, I feel it's even more important to find out what type of student we are dealing with before deciding which assessment works better. For example, when we test our students in our building, we know certain students with extra barriers (language, attention span, etc.) will benefit more or will show their abilities better in a computer assessment versus paper/pencil. So, teachers decide to give them the computer assessment! It's not really a matter of what but WHO is taking the test! (Andrea, third-grade teacher).

**CHAPTER REVIEW**

**Key Points**

Each chapter in this text includes a Key Points Review that summarizes chapter ideas.

- **Explain why a learning focus is important in supporting learning with technology.**

Technology is a tool that teachers can use to support learning, but learning must be foremost. If teachers do not understand how to support learning, technology use will be ineffective and inefficient. Kleiman (2001) summarizes the focus of this text, noting that "while modern technology has great potential to enhance teaching and learning, turning that potential into reality on a large scale is a complex, multifaceted task. The key determinant of our success will not be the number of computers purchased or cables installed, but rather how we define educational visions, prepare and support teachers, design curriculum, address issues of equity, and respond to the rapidly changing world" (p. 14).

- **Describe the relevant standards and the 21st-century skills that ground the learning in this text.**

The integration of content area and technology standards, along with standards for English language learners, results in six 21st-century skills that can serve as learning goals in the creation of technology-supported learning tasks:

- Content learning
- Critical thinking
- Communication
- Problem solving
- Production
- Creativity

**Define "educational technology" and related terms.**

Pencils, chalkboards, and overhead projectors are all educational technologies. However, in today's classrooms, educational technology is usually understood to be electronic technologies, particularly

computers, that are used to support the learning process.

- **Discuss the use of technology tools for providing access to learning for all students, including physically challenged students, English language learners, and others who might face barriers to learning.**

Hardware, software, and connection are the main components of electronic technologies. Specific applications of these components can determine whether students can access the content and demonstrate their skills.

- **Present an overview of computer-based and computer-assisted assessment practices.**

There are many ways to assess student learning in every classroom. This idea does not change when technology is integrated, but technology use can make assessment easier and more effective.

- **Understand how and why to adapt lesson plans for more effective learning.**

Evaluating lessons according to criteria for effective technology-supported learning can help you provide instruction that is accessible, engaging, and useful for all students in your classroom.

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II

# PART II

# 3
# PART II Supporting Student Learning with Technology

CHAPTER 2. Supporting Student Content Learning

CHAPTER 3. Supporting Student Communication

CHAPTER 4. Supporting Student Critical Thinking

CHAPTER 5. Supporting Student Creativity

CHAPTER 6. Supporting Student Problem Solving

CHAPTER 7. Supporting Student Production

CHAPTER 8. Supporting Student eLearning

# 4
# Chapter 2 Supporting Student Content Learning

Because content knowledge is seen as fundamental to what schools do, the standards in every subject area list, sometimes explicitly, what content students should grasp to be considered knowledgeable. Words like “understand,” “identify,” “memorize,” and “recognize” are used to describe the content that students should be able to work with. The key to content learning is to understand how content is learned, including what skills are needed and how technology can help.

## OVERVIEW OF CONTENT LEARNING AND TECHNOLOGY IN K–12 CLASSROOMS

Content knowledge is essential for students in order to meet student learning goals such as problem-solving and effective communication. Teachers should first understand the importance of content learning and then how it can be learned and supported by technology while students work toward learning goals.

### What Is Content Learning?

There are two parts to the question “What is content learning?” The first, what content is, seems rather basic, but the second, what learning is, can be fairly complicated. A look at how content knowledge is acquired can help to answer both parts of the question.

Researchers and educators typically divide knowledge into three categories: declarative, structural, and procedural. Declarative knowledge consists of discrete pieces of information that help us identify things and events (Wignall, 2005). For example, declarative knowledge includes the definition of “democracy” or the names of all the U.S. presidents. Declarative knowledge forms the basis for all other types of knowledge and is essential for students to achieve more complex goals such as creative and critical thinking, communication, production, and inquiry. It is often learned through memorization, drill, and practice, although a variety of scaffolding strategies such as mnemonics, concept mapping, and metaphoric techniques support the acquisition of simple facts. Software packages from NASA and other agencies,in which specific facts are the focus, can help students to acquire and practice declarative knowledge. However, students must also have structural and procedural knowledge to carry out the functions in these software packages.

Structural knowledge is an understanding of how pieces of declarative knowledge fit together. When

students have pieces of information among which relationships are created in their minds, this information has been contextualized and/or schematized. Another way to describe structural knowledge is as information that has been developed into a mental model. For example, structural knowledge includes the understanding that a toothbrush is necessary to brush teeth, or that evaporation is related to liquids. Structural knowledge can be represented through, for example, concept maps, categorizations, and classifications, and it is supported by concept-mapping software such as Inspiration or Kidspiration (www.inspiration.com). When learners focus on relationships among pieces of information, they acquire structural knowledge. This leads to the ability to use higher order thinking skills.

Procedural knowledge is the knowledge of action, or the knowledge of how to do some- thing (Williams, 2000). Examples include how to speak Spanish, how to teach with technology, how to drive a car or use a cell phone. It is based on declarative knowledge but learned through the relationships in structural knowledge. Teachers often access procedural knowledge through student performance, having students construct a technology-enhanced product such as an essay, a presentation, or a graphical representation of a concept.

Traditionally, many educators have thought of declarative knowledge as “content,” and some of the older standards reinforced this view by listing discrete pieces of information that students should know; this is no longer the case. The majority of standards now list procedures that students should be able to carry out, so simple declarative knowledge is not enough to say that students “know” something. Students must also be able to do something with the knowledge/content to show that they have mastered it.

Educators have mixed views of when students can be deemed knowledgeable about a subject—and legislators and tests often determine the current understanding. For example, some claim it to be when students have memorized the names of the scientific elements and others when they can use the periodic chart to make statements about living things. In other words, while information-knowing is the goal set for some students, knowledge creation is the goal for others. Teachers who do not go beyond declarative knowledge teaching and testing, however, are doing their students a disservice by ignoring students’ needs to be able to make connections and to use knowledge to act.

It seems a rather simple matter for students to learn content, but it is far more complex than most people think. Some content, and the relevant skills needed to learn it, is disciplined-based; for example, science uses a different form of exploration and expression than English literature, and the way that math is presented, used, and produced is different still. This implies that different ways to learn and teach content might be necessary across disciplines.

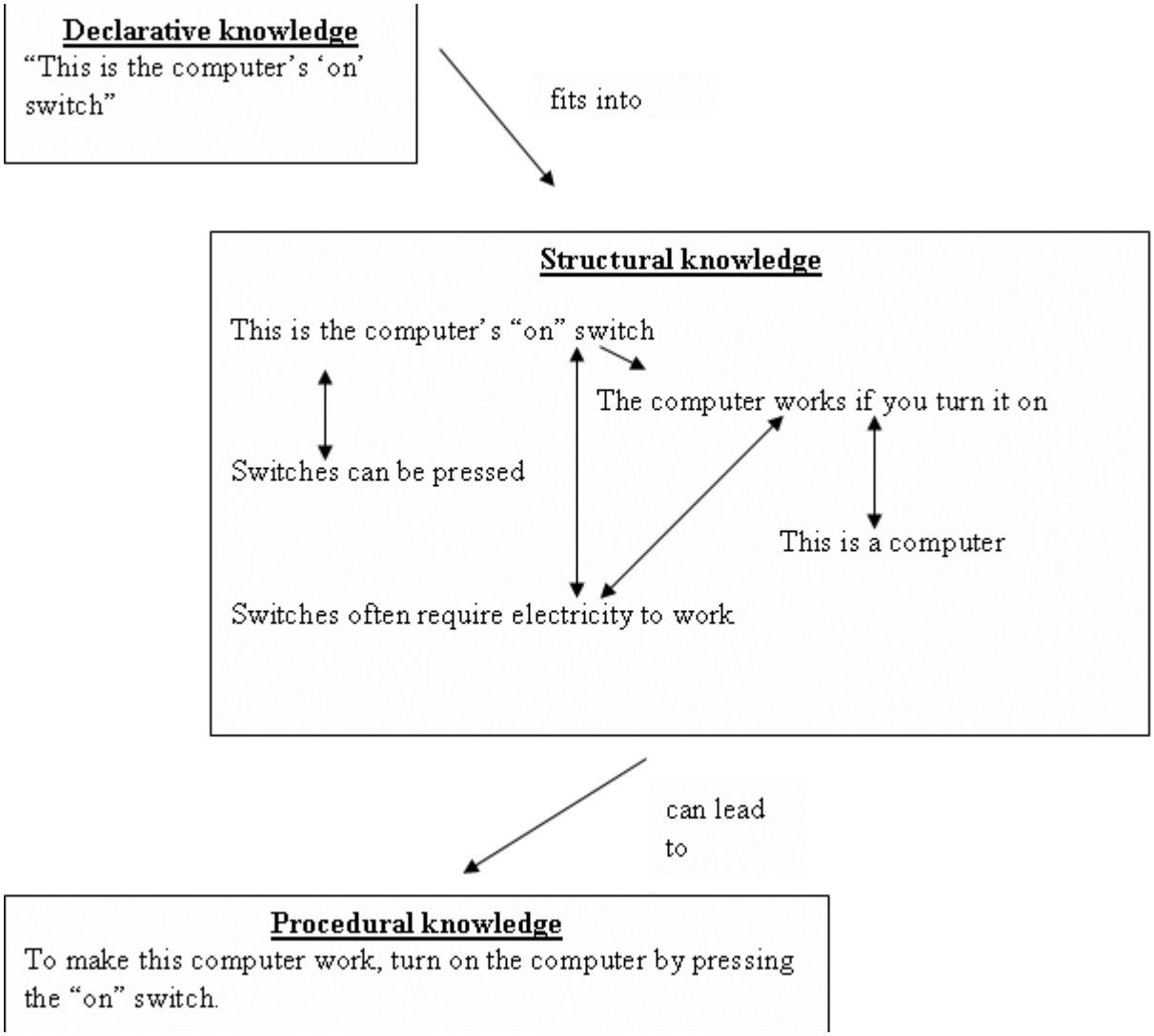


**FIGURE 2.2 Simple Model of Knowledge Acquisition**

In addition, although brain science is making great strides in providing information about how and why people learn, the factors that make students learn in different ways are still not entirely clear. It is clear, however, that individual sets of factors such as culture, economic status, first language, educational background, and age can affect learning on a person-by-person and day-by-day basis (Norman, 2004). In addition, brain research has also shown that stress hinders learning (Willis, 2014) and that "emotionally important content learned in school is very likely to be permanently remembered" (Erlauer, 2003, p. 13). That means that content that is tied in some important way to learners' lives will have more impact on their learning. Clearly, both internal (i.e., learner characteristics) and external (i.e., environmental) factors contribute to knowledge acquisition. Teachers can consider all of these ideas as they plan content lessons supported by technology. Figure 2.2 presents a simple model of the relationships among these knowledge types.

Physical Contexts for Technology-Supported Learning

Among the external factors that affect learning, the classroom environment, focusing on the

arrangement of technology, is important to discuss. Although some external factors are not under the teacher's control, the teacher often has choices in setting up technology in the classroom and school.

The physical arrangement of the classroom, including placement of desks, whiteboard, and other resources, can affect how students learn because the roles that these resources, including technology, can play vary by how the classroom is designed. Most teacher education programs address the physical environment in their classroom management course, but the importance of the location of technology, particularly computers, is often overlooked. As Wade (2016) asserts, classroom design can support good teaching by facilitating the use of the equipment or removing barriers to good use.

Technology can be configured in many ways. Typical designs are a one-computer classroom, multiple-computer classroom, and lab, and all of these configurations can be used for different activities at different grade levels.

One-computer classroom

Although not typically the optimal situation for all students to receive maximum benefit from the power of computing, a lot can be done with one computer. For example, the teacher can use the computer to provide pre-reading exercises, focus whole-class discussion, or lead teams through a game or simulation (other examples are provided throughout this book). However, the computer must be accessible to all students; in other words, it should have a high-quality projector or large monitor attached, and there must be room for all students to sit, view, and participate. In addition, students with special needs must have access to tools that help them to participate. These include special keyboards, screen readers, and other tools described later in this chapter.

Excellent content software and resources for K–12 that make effective use of the one-computer classroom are available from Tom Snyder Productions (http://teacher.scholastic.com/products/tomsnyder.htm) and Sunburst (http://www.sunburst.com). For example, in Tom Snyder's Decisions, Decisions series, the software presents a scenario and then offers students choices of how to proceed. With the teacher facilitating, the students discuss the issues and come to a decision as to which choice is best based on the information they have. The software shows the consequences of that action and presents students with another choice, and the task concludes after several additional decisions.

Multiple computers

In a classroom of 25 students, three to five computers do not seem like much help, and they are not if they are relegated to a corner of the room and only used for free time or remediation. However, separated into activity centers, they can blend into the daily workings of the class and be integrated into classroom goals. For example, in a classroom where students are producing books, one center could be used for research, one for development, and one for printing. Or, where students are studying ancient Egypt, each team of students could work with their topic in a different area of the classroom.

Lab

There are all kinds of designs for computer labs. Unfortunately, the most common is still computers in separate carrels or in rigid rows that create physical barriers between the students and teacher or the students and their peers. This makes it difficult for students to collaborate, use other spaces for learning, and observe modeling by and receive feedback from the teacher. Even though, as Theroux noted in 2004, the "most difficult and least effective way to integrate technology is to consistently take all students into the computer lab to work on the same activities at the same time" (p. 1), this very thing still happens in many schools. The problem is that the individual nature of the lab setting is a barrier to working with the teacher or other students, and the activity conducted in this setting probably does not consider differences among students in technology skill or content knowledge.

A variety of effective alternative arrangements can make a lab setting a more flexible and useful space. These arrangements include furniture such as hideaway desks into which the monitor can be completely recessed (shown in Figure 2.3), groupings such as pods of four to six computers, and tables where students can work offline. These arrangements can all contribute to making the computer classroom a place where instructional goals can be met.

**FIGURE 2.3 Hideaway Desk**

Source: Used with permission of Computer Comforts, Inc.

Carts

Another useful layout, and a quickly-growing trend, for schools that do not have a critical mass of computers is a laptop cart, or a set of computers that rotate among classrooms. Students use the computers for a day to several weeks to participate in technology-intensive projects, and then the

technology moves on to another classroom. Many schools use mobile labs (moveable carts that store 20–30 laptops) to provide computers to classrooms when needed.

Equal access

Whichever layout is chosen, the Americans with Disabilities Act (ADA) and state and local regulations require that all students have equal access to the technology. To make sure that there are as few physical barriers as possible, teachers, students, and school staff can make it a point to make sure that:

Pathways in classrooms and labs are wheelchair accessible.

One or more desks allows for wheelchair access.

The printer and other peripherals are located in easily accessed locations.

Any tables or other work spaces are at a variety of heights.

Assistive devices such as screen glare reducers, alternative keyboards, and screen readers that might be used fairly often are immediately available.

Any important documents are available in a variety of formats and prints so that diverse users can access them.

Web sites and other technologies are accessible.

For more information about equal access and free tools to support it, visit the CAST Web site at www.cast.org.

To determine the technology's layout and design, we must consider what students need to do with the technology and what design allows them to do it. Many technology experts recommend that administrators and teachers view other classrooms and expert designs before making decisions about the layout of technology. Some ideas are available in photo shots at www.fno.org.

Other technologies

The availability and accessibility of cameras, handhelds, microphones, tape recorders, document cameras, printers, and other hardware tools also need to be considered for effective student learning. How will they be accessed? Where will students need to and be able to use them? Wade (2016) suggests that teachers ask students how they use classroom tools and plan accordingly. Make sure that school administrators know that tools that are locked in a closet on the other side of the school or can only be checked out on Thursday morning provide little support for content learning.

Other considerations in the physical space

Educators suggest that a computer is needed for every 3–4 students for all students to have the access

they need to participate in effective technology-enhanced tasks; other educators are convinced that 1-to-1 programs, in which every student has a computer, are the most effective. In the end, how much technology is needed depends on what the technology will be used for. Not all the computers need to be the newest; rather, students can draft assignments on lower-end computers and use better ones for more advanced tasks. An important consideration is that students have storage space on the network so that they can move from computer to computer on the network and even access their files at home through Dropbox or Google Docs and not be tied to one computer.

There is no one right way to design the layout of technology to support student learning. Whichever layout teachers and technology coordinators decide on, they need to understand the implications for learning. This goes for other tools as well; sometimes electronic technologies do not provide authentic information and sometimes the information is not exactly what students need. Therefore, the physical space assigned to desktop computers should also provide access to other basic resources such as books, films, and a variety of other tools that might be more reliable, easier to access, and easier to carry.

## Characteristics of Effective Technology-Supported Content Learning Tasks

Teachers teach from different philosophical standpoints, and students learn based on many different variables—such as the arrangement of the classroom, as noted above—many of which are discussed throughout this text. However, there are basic principles of teaching and learning that support all of the learning goals. Following these principles in task development can help teachers to support all students, including those who are often underserved, such as ELL, gifted, and students with special needs.

In general, effective content learning tasks

Engage students. Students are motivated and find the tasks meaningful. Work does not always have to be “fun,” but it should be interesting and meaningful and take place in an environment where they feel safe.

Help students become responsible for their own learning, in whole or in part. If students are engaged, teachers can use a gradual release of responsibility to move students toward independent learning (see Fisher and Frey, 2013, for an explanation and ideas; an excerpt from their book is available at http://www.ascd.org/publications/books/113006/chapters/Learning,-or-Not-Learning,-in-School.aspx). To do so, tasks must allow students to investigate some of their own questions rather than having them supplied.

Encourage students to be strategic. During effective tasks, students make systematic, thoughtful choices of how to meet learning challenges. They decide which strategies, resources, and tools will help them complete the task.

Require collaboration. Effective learning takes place through interaction with others, so tasks must require that students work together, share information, and contribute to the understanding of others (Vygotsky, 1978).

Focus on essential questions. Rather than just gathering information, students need tasks during which they frame and investigate important questions. Such tasks are more likely to use technology well, engage students, and lead to gains in learner achievement. Lists of sample essential questions exist around the Internet, including those by Crockett (2016) at https://globaldigitalcitizen.org/100-awesome-essential-questions and "A Giant List of Really Good Essential Questions" at http://www.teachthought.com/critical-thinking/questioning/examples-of-essential-questions/.

These questions integrate the need for declarative knowledge, or data, with a requirement to consider, transform, and make decisions that result in insight. Instead of content knowledge being only the forbearer of other types of thinking such as problem-solving or creativity, gains in content knowledge are also a result of those types of thinking. Examples of student research with essential questions can be found at http://questioning.org/. A more thorough explanation of the research process can be found in Falk & Blumenreich (2005).

In other words, content can be learned before, throughout, and as a result of working toward learning goals such as critical and creative thinking, communication, production, and inquiry. Students who learn content as procedural knowledge can also perform well on tests of declarative knowledge and on performance assessments. On the other hand, learning content solely through information gathering can result in students handing in hundreds of pages of data printed directly from the Internet and not understanding a single page.

## THE TECHNOLOGY-SUPPORTED CONTENT LEARNING PROCESS

Figure 2.2 showed relationships among declarative, structural, and procedural knowledge. Although the exact biological and psychological mechanisms that lead to the acquisition of declarative knowledge, and in turn to the other types of knowledge, are not known, it is fairly clear that new content is attached to old content in the brain in some way (see Sousa's fascinating book, "How the Brain Learns," for findings from recent educational neuroscience and how to apply them in classrooms); therefore, for tasks to be meaningful they must activate students' prior knowledge.

Although we do not yet know the specifics of how the brain processes content, teachers can still teach and observe student outcomes to help understand how these links are made in classrooms. Content

learning in classrooms occurs through general stages of planning, engaging, and evaluating. During an effective content learning process, students:

Understand where they are supposed to go. Goals and objectives are clear and accessible to all students, including those who speak different first languages and others who access information in diverse ways.

Assess their current knowledge and skills and the level of each. Students should reflect on how they can reach the goals and what knowledge and skills they need to get there. Planning is facilitated by the teacher, peers, and others.

Engage in activities that help them to acquire the knowledge and skills they need. Students must find and be given resources that directly apply.

Evaluate how they did. Feedback from the teacher and others, self-reflection, standardized tests, comprehension questions, and interviews contribute to an understanding of the extent to which goals were met.

This outline does not really speak to how each step in the process is carried out specifically—teachers have to make that choice knowing their students. For example, in a diverse class of first graders, the teacher may decide that both a teacher-fronted discussion and cooperative group work will help the students understand their task. After she has worked with her learners for a while, she may skip the teacher-fronted discussion and go right to the cooperative group format for task instruction. In eighth grade, one English teacher may use a spontaneous writing task to evaluate the level of written proficiency for her class; another English teacher may decide to give both a standardized test and interviews because she knows that her students perform differently on different tasks. Figure 2.4 presents an overview of the content learning process.

FIGURE 2.4 Overview of the Technology-Supported Content Learning Process

| Student Stage | Ideas for Technology-Supported Implementation |
|---|---|
| Understand | Make overall learning goals and objectives clear. Present them in many ways—text, audio, graphics— and refer back to them during the process. |
| Assess | Help with personal goal-setting and current understanding of content knowledge. Use Inspiration and other graphical organizers to describe declarative, structural, and procedural knowledge. |
| Engage | Provide appropriate resources and make sure that tasks work toward learning objectives. Give students access to Web sites, book lists, content software, and experts. |
| Evaluate | Provide feedback through test scores, interviews, and other assessments and allow opportunities for self- reflection. Students can use a word processor to create knowledge summaries and digital sound recorders to record observations and ideas. |

Teachers and Technology-Enhanced Content Learning

In any classroom, the teacher's role in the content learning process may change from task to task, and task-specific challenges may arise for both teachers and students. Understanding both possible roles and potential challenges is crucial for teachers.

The teacher's role in content learning

To help students move from declarative knowledge to structural and procedural knowledge, teachers can guide students to make connections, test hypotheses about how things work, and explore how ideas go together. Realistically, for expediency and to meet some student needs, the teacher's role must sometimes be to model, demonstrate, or lecture to the whole class. At other times, the teacher can facilitate and support as students explore.

Challenges for teachers

Because content teaching often occurs while students work toward the learning goals of critical thinking, problem-solving, communicating, and so on, many of the same challenges are present whether electronic technologies are used or not. However, computer use presents some particular challenges. For example, plagiarism (discussed in chapter 6) can be particularly rampant with Web-based research or content-gathering projects. However, by asking students to answer essential questions rather than just having them gather information, plagiarism can be controlled to some extent.

A real challenge for teachers using technology is to first learn the technology; teachers cannot help students with technical issues if they do not understand the software and/or hardware. Tips and guidelines throughout this text suggest ways for teachers to overcome this barrier, and resources are offered in chapter 9.

Time, always an issue for teachers, is an especially relevant challenge in content teaching and learning, especially with pressures to cover the curriculum, having to teach students research skills, and competing with other teachers for resources. The use of expert teacher or student groups that have mastered a concept or technology and can teach it can help with time issues. Additionally, resources such as Kids Click (http://www.kidsclick.org) give teachers a list of Web sites that have already been evaluated for use by students. Other useful resources that are prefiltered or otherwise appropriate for

students include visual search engines such as Kiddle.co (http://www.kiddle.co/), KidRex (http://www.kidrex.org) and Awesome Library (http://www.awesomelibrary.org/AwesomeLibrary-Languages.html), which uses the Google Translate application to translate results into a variety of languages. For older students, Google has a safe-search setting that can set and locked in the Firefox browser.

Learning to use and integrate technology with educational goals, especially specific content, does take time and effort. However, it can be made easier. Start with the essentials as presented in this book—an understanding of how students learn, what the goals of education are, what steps can be taken to help students achieve, and how technology can help. Then, by applying strategies mentioned throughout this book, learn more about what technology works in your specific contexts. One very effective and often overlooked resource is the school library media specialist, who is specially educated to support learning with technologies of all kinds.

GUIDELINES FOR SUPPORTING TECHNOLOGY- ENHANCED STUDENT CONTENT LEARNING

Content teaching is the focus of many teacher education programs, but more important is to understand how to make content learning most effective. The guidelines in this section focus on how to give all students opportunities to learn.

Designing Opportunities to Learn Content

All students can and do learn something, regardless of how they are taught. However, to focus that learning in productive ways and maximize learning gains, teachers can follow these guidelines:

Guideline #1: Incorporate principles of just-in-time teaching. Just-in-time (JIT) teaching is teaching that occurs just when it is needed (Prince & Felder, 2006), but it is more planned than what educators call a "teachable moment," or a spontaneous opportunity to introduce a new concept or idea. As a complement to an ordered, standardized series of lessons that accomplish the curriculum, JIT learning delivers skills and information when students can best use, learn, and remember them. For example, an ELL who is working on reporting a historical event needs to know how to form and use the past tense of verbs, and JIT presentation of this grammatical concept will occur effectively during the broader task. When the teacher observes that the student needs this information, she can tutor the student, provide resources for the student to check, or assign another student to explain the concept. As another example, during the study of an abstract scientific concept in the textbook, some students might need a JIT lesson in finding the main ideas, particularly if their preferred learning style is visual or kinesthetic. The teacher can meet with the small group and teach a lesson on main ideas, have students use a computer program such as Tom Snyder's Reading for Meaning (Scholastic) to practice finding main ideas, or assign class "reading experts" to work with those who need help.

Students do not often grasp the utility of a concept or the connection of ideas when they are first presented if there is not a true need to know. JIT learning necessitates careful observation by the

teacher so that she can provide help and scaffolds when needed. It also requires teachers to have resources ready, or train students to access them, for potential areas of need, and to guide students in whatever way they need through the information. Technology can support JIT learning and teaching in many ways; for example, the vast amount of information that is accessible in various formats and languages on the Internet means that ELLs and other students can find help on just about any issue. When the student asks the teacher for help with a grammar topic or needs a more simplified explanation of a science topic, the student can probably find something on the Web to help. However, the teacher's guidance is still central to ensuring that students find the information they need and use it in appropriate ways.

Guideline #2: Differentiate instruction. One of the chapter 5 tips recommends enriching the classroom environment through the use of materials that appeal to students' different senses and intelligences. From that discussion it is clear that students respond to different kinds of enrichment. Differentiated instruction is another way to provide enrichment for students' abilities, interests, and learning needs. In differentiated instruction, the goals and concepts are the same for all students, but the challenge varies. Teachers can differentiate instruction by giving students several different options in their work; some students will take different options at different times, depending on varying interests, subject-area ability or readiness, and learning preferences. Teachers can start out slowly by varying the content, process, product, or tool, or they can provide choices in any or all four at different stages of an activity.

Technology can help differentiate instruction by providing a variety of tools for different tasks at different times or for the same task by different students. For example, in a unit about bugs, one group of students may access information about how bugs communicate by using the videos and games in the Sidewalk Science program "Bugs" (Scholastic), while more proficient students might use a Web site such as http://insectzoo.msstate.edu/. Less proficient students might use another tool that is suited to their level. For all students, but particularly ELLs and students with diverse needs, differentiated instruction can provide opportunities to access the content and language they are learning, an essential component of learning. Find out more about differentiated learning from Edutopia at https://www.edutopia.org/blog/enhanced-learning-through-differentiated-technology-julie-stern.

Guideline #3: Teach in a culturally responsive manner. Research shows that students whose lives are addressed and supported in classrooms learn better and achieve more. Teachers can make sure this happens by teaching in a culturally responsive manner. This means using materials that are culturally relevant, or that celebrate the lives and heritages of all students and reflect the contributions of all groups (see, for example, Egbert & Ernst-Slavit, 2017). Being culturally responsive empowers learners and makes learning meaningful for them, whether they are from another country, a different religion, or a minority group. For example, many groups throughout history have contributed to our current understandings of math, from the discovery of zero (see an overview at http://www-groups.dcs.st- and http://www-history.mcs.st-andrews.ac.uk/HistTopics/Zero.html) to contributions by women and people of many ethnicities. Teachers can access culturally relevant information both on the Web and through software such as Culturegrams (http://www.culturegrams.com/). Teachers can also find lessons on the

Web that suggest different ways to be more culturally responsive. Additionally, by connecting with families through software such as Podkeeper (http://www.podkeeper.com/), the school-based PowerSchool (https://www.powerschool.com/), or the local communication software, teachers can find help in understanding and integrating learners' cultural resources.

Guideline #4: Adapt materials to be accessible for all students. Teachers can adapt, modify, and enhance materials in many ways to make the content more accessible to students. Adaptations can include:

Using graphic depiction

Outlining the text

Rewriting the text

Using audiotapes

Providing live demonstrations

Using alternate books (Echevarria & Graves, 2002)

However, it is important that adapted materials not sacrifice academic content for simplistic understandings. Adaptations allow ELLs, students with various physical impairments, and students with different learning preferences to have equitable chances to access the materials.

As Egbert (2005) notes, teachers do not have to make all of these changes themselves—they can enlist more proficient students to help, work in teacher groups and share materials, and find these materials on the Web.

Guideline #5: Balance content and tools. When computer technologies are adopted, learning the technology tools often takes precedence over learning the content. Teachers can help students find a balance between the two. For example, a student's first PowerPoint presentation does not have to include audio and video. In addition, make it easy for students to save their work in the cloud (e.g., in Dropbox or Google Docs); losing work that then has to be redone not only frustrates students but wastes considerable time and energy. Given the extra learning time that technology use might add to a project, plan more time for projects that involve technology, including technology down times and problems. Teachers can decide not to use digital technologies in favor of traditional content learning. However, striking a balance between the two often leads to achievement in both. Figure 2.5 lists the guidelines from this chapter.

FIGURE 2.5 Guidelines for Content Teaching

| Suggestion | Ideas for Technology-Supported Implementation |
|---|---|
| Understand | Make overall learning goals and objectives clear. Present them in many ways—text, audio, graphics—and refer back to them during the process. |
| Guideline #1: Incorporate just-in-time learning. | Have mini-lessons ready to go on topics relevant to the lesson. Bookmark Web sites ahead of time. |
| Guideline #2: Differentiate instruction. | Vary content, process, product, and/or technologies to give students a variety of possible challenges. |
| Guideline #3: Teach in a culturally responsive manner. | Connect with parents to better understand students' home cultures. Send technology and the products of technology home to share with parents. |
| Guideline #4: Adapt materials. | Find, create, and share materials that have been modified to work with different ability levels but the same content. Set up a database by grade/topic/curricular goal that all teachers can access. |
| Guideline #5: Balance content and tools. | Use the simplest technology that serves the purpose when starting out. Add features as projects and activities warrant and extensions for those capable. |

## CONTENT LEARNING

Most teachers have a pretty good idea of how to teach content, but they may not understand as well how technology can help. Of course, students can get facts and information from software and Web sites, but how does technology help content learning result in more than declarative knowledge? For one, it can offer students multiple representations, opportunities to learn connected ideas, ways to learn in meaningful contexts, and support "rich and connected knowledge," people, and tools (U.S. Department of Education, 2014, p. 5). For example, students may understand that towns need people and that people need schools and so on. However, until they use the simulation SimTown or MySims (Maxis) to create their own towns and watch their towns succeed or fail, they may not understand how a complete town system really works.

In addition, students can obtain all kinds of raw data that do not have meaning until they transform the data in some way. For example, the National Center for Educational Statistics (nces.ed.gov) compiles data on education trends across the nation. Until students transform and apply the statistics to look at how the numbers are affecting their lives and communities, they may not understand the impact of demographics on their lives.

Many Web sites emphasize content learning, such as the Student Page of the global Cable News Network site (http://www.cnn.com), the U.S. National Aeronautics and Space Administration site (http://www.nasa.gov), and sites like Jeff Whitlock's Online Zoo (http://www.theonlinezoo.com/). In addition, professional organizations such as the National Council of Teachers of Mathematics, the National Science Teachers Association, and the International Reading Association suggest many useful

sites for content learning. Students can also use office software such as PowerPoint, Excel, Google Docs, and other multimedia development packages to compile and report their findings. ELLs can use these tools successfully if their use is carefully planned so that the language and content are made accessible to the students. Teachers can add external documents, as described in chapter 4, and provide any necessary organizers, prompts, or adaptations to make the content and language relevant and authentic. Free office tools with many of the capabilities in the ubiquitous but often expensive Microsoft Office Suite include the Google Apps for Education suite of Docs, Sheets, and more. All Google apps have the capability to be saved in alternative formats such as .doc and .xls, and student work is automatically saved. In the classroom, teachers and ESL students can also use native language-specific and bilingual Web sites as interactive tools for content learning.

## EVALUATING TOOLS

New and "improved" content-focused tools for ELLs, special needs, and traditional students are introduced in the market all the time. These tools need to be carefully evaluated to justify the cost and to ensure they meet learning goals. Although having one teacher evaluate the tool is better than purchasing it without a review, it is better to use it in a classroom for its intended purpose to see how well it helps meet learning goals.

How should software and other tools be evaluated? Multitudes of Web sites and books suggest evaluation schemes and usability tests (i.e., an observation of the actual use of the product by a target user). Excellent resources can be obtained from ISTE (http://cnets.iste.org) and on Kathy Schrock's amazing Web site at http://kathyschrock.net/. Most of these resources suggest that tools must be evaluated according to the context in which they will be used. Because schools and programs differ widely, this means that evaluations should be adapted to each situation. In many cases this can work, but in others it is not feasible due to personnel, time, and budgetary constraints. Some software companies will lend software to teachers for a free 30–90-day trial, and time extensions are often granted. Otherwise, demonstration or short-term versions of software are almost always available from publishers. If the Web site or package does not mention these options, teachers can contact the publishers for information and help.

The diversity of context and other situational features means that teachers and IT coordinators often use a general, premade form that has a broad fit with the school's purposes. However, teachers who need to evaluate software tools can also rely on others who have already done some of the work. Many software review sites exist, and a check of multiple sites might help teachers eliminate a software package from their list or decide to try it in their own classrooms. In addition to comments on sites such as Google, iTunes, and Amazon, free sites that can save time and money include:

EdSurge's comprehensive site at https://www.edsurge.com/product-reviews

Graphite, from CommonSense.org, which also has a searchable database for digital support for the Common Core Standards (https://www.commonsense.org/education/standards/common-core)

https://edshelf.com/, which also features a searchable database and comments from educators at every level.

Some of these sites even suggest software that a school or program might not have considered. Also, to save time and energy, ask colleagues for their thoughts on software they have used.

## LEARNING ACTIVITIES: CONTENT LEARNING

In addition to effective content-based classroom learning, students need to participate in activities that help them to understand the foundations of technology use, including concepts of ethics. Integrating technology throughout the curriculum may seem like an overwhelming task. As described above, there are many technologies to help teachers present content. The problem is how to get started. McKenzie (2004b) believes that we can "invent curriculum rich lessons that take students half an hour but engage them in powerful thought with considerable skill." He says this can happen through "tight lesson design, no waste, no bother and no wandering about." He calls these short, structured, Web-based lessons "Slam Dunk Digital Lessons." Slam Dunks are tasks that focus on content learning through essential questions and Web-based resources. Teachers can integrate Slam Dunks into larger lessons or units (see http://fno.org/sept02/slamdunk.html for a brief, clear explanation) or use them as a starting point to develop lessons that integrate technology.

The basic format of the lesson consists of these six parts:

The essential question and learning task: The important question that students will have to work to answer, along with any other preview of the material and a picture if appropriate/ available.

The information source: A picture and information about the site(s) appropriate for your students that they will use to answer the essential question.

The student activity: What students will do with the information, typically completing some kind of graphic organizer using the links provided.

The assessment activity: The performance or product that will show what students understand.

Enrichment activities: A brief list of extra sites that have been checked for appropriateness.

Teacher support materials: Helpful hints, standards, instructions, and objectives.

For more details and examples, go to http://questioning.org/. McKenzie recommends building the lesson from the foundation of one or more content standards. The learning activities that follow adapt the

basic Slam Dunk outline to demonstrate how digital tools can be used in different content areas to meet specific content standards. Each activity can be modified to make it effective for older or younger learners. As you read, think about the kind of content learning (declarative, structural, or procedural) each activity is designed to help students achieve.

……

Question: Why do we need to understand fractions?

Source(s): Math is Fun, https://www.mathsisfun.com/fractions.html

Activity: List all the ways that you use fractions during your day.

Assessment: Write a summary of your answers and share it with peers.

Enrichment:

Kahn Academy, https://www.khanacademy.org/math/arithmetic/fraction-arithmetic/arith-review-fractions-intro/v/fraction-basics

Identify with circles, http://www.visualfractions.com/EnterCircle.html

Fresh Baked Fractions, http://www.funbrain.com/fract/

Support: Understand commonly used fractions (math standard)

……

Question: Which body system is the most important?

Source(s): Human Anatomy Online, http://www.innerbody.com/htm/body.html

Activity: Chart the parts of the main body systems and their roles in the body.

Assessment: Write a brief position statement based on the data that answers the question “Which body system is the most important?”

Enrichment:

The Virtual Human Body, http://www.ikonet.com/en/health/virtual-human-body/virtualhumanbody.php

Interactive Body, http://www.bbc.co.uk/science/humanbody/body/index_interactivebody.shtml

Atlas of the Body, http://www.ama-assn.org/ama/pub/category/7140.html

Support: Describe the basic structure and functions of the human body systems. Students will learn what the body systems are and the roles they play (science standard).

……

Question: If you had to eliminate one of the rights in the Bill of Rights, which would it be? Source(s): The Bill of Rights: Evolution of Personal Liberties (CD-ROM from socialstudies.com)

Activity: Create a chart with pros and cons for each original amendment.

Assessment: Work in groups to choose one amendment to eliminate and defend your choice.

Enrichment:

The National Archives, http://www.archives.gov/national_archives_experience/charters/bill_of_rights.html

ACLU Student Rights, http://www.aclu.org/ (search "students")

The Bill of Rights, http://www.billofrightsinstitute.org/

Support: What is the U.S. Constitution and why is it important? (social studies standard)

The approach in this lesson involves the same content as a traditional overview of the Bill of Rights but requires students to understand the issues more deeply and to make an untraditional choice.

……

Question: Your school has money to purchase one piece of art by an American painter to display in the main hallway. Which piece of art should it be?

Source(s): Inventories of American Painting and Sculpture, http://americanart.si.edu/research/programs/inventory/

Activity: Choose five pieces of art from different genres. Create a table that includes the art's "message," its defining characteristics, and reasons why it should be displayed in the school.

Assessment: Peers from around the school vote on the choices.

Enrichment:

Whitney Museum of American Art, http://www.whitney.org/

National Gallery of Art, http://www.nga.gov/content/ngaweb/education.html

Support: Students know the differences among visual characteristics and purposes of art; students

describe how different expressive features and organizational principles cause different responses (art standard). As a follow-up, students can make interpretive versions of the artwork chosen.

……

Tasks like these that provide structure and appropriate resources and clearly meet standards might be the ideal tool for teachers who are just starting to integrate technology into their teaching. The tasks above are also useful to help students understand how to frame essential questions that include why? how? and which?

## ASSESSING CONTENT LEARNING: SCORING GUIDES

Because content knowledge plays an important role in meeting other learning goals, teachers must assess content in ways that help them understand what students know and can do. As suggested in this chapter's learning activities section, students can be assessed through technology-supported summaries, retellings, and debates. Content knowledge can also be assessed through rubrics (chapter 3), tests (chapter 4), and a variety of performance assessments (chapter 6). The North Central Regional Educational Laboratory (NCREL) suggests that in addition to assessing students, teachers should evaluate their own instructional design and assessment process. To do so, they can employ scoring guides. Scoring guides are like rubrics, but they are used to evaluate learning in a broader sense than more local rubrics. The three functions of scoring guides are:

To help teachers and evaluators evaluate student learning in a relatively objective way based on predetermined standards

To identify and assess not only student learning but also instructional design

To serve as models for teachers in developing their own rubrics for a wide variety of assessment purposes. (NCREL, n.d.(b), p. 1)

Figure 2.13 provides an example of one way to evaluate technology use in a lesson plan.

**FIGURE 2.13 Scoring Guide**

| | 5 | 4 | 3 | 2 | 1 | 0 | Comments |
|---|---|---|---|---|---|---|---|
| Standards/ Learning Objectives | Curriculum standards and learning objectives are specific and focused, intentionally driving the use of technology. | | Curriculum standards and learning objectives are correlated to technology uses. | | Curriculum standards and learning objectives are superficial uses of technology. | No demonstration of curriculum standards and learning objectives connected to the use of technology. | |
| Curriculum Linking with Technology Uses | Curriculum linking creates unique content learning benefits.<br><br>Content learning experiences/benefits are extended and would be impaired or impossible without the use of technology. | | Curriculum linking adapts or varies present student learning or work.<br><br>Content learning experiences or benefits are enhanced but possible without the use of technology. | | Curriculum linking provides topics" for technology skills or uses.<br><br>Content learning incidental—student uses primarily to learn/practice technology skills. | Curriculum linking is incidental to technology use.<br><br>Content learning not focused. Technology uses are mostly supplemental, or to provide fun/ motivation activities. | |
| Cognitive Tasks | Task requires synthesis and evaluation of information. Going beyond existing understanding to create own original position or product. Knowledge creation is expected. | | Task requires analysis of information and/or putting together information from several sources to demonstrate an understanding of existing knowledge. | | Task requires little analysis and is focused on simplistic tasks or concepts using a single source. Cookie-cutter, look-alike products are likely to develop. | The task has little relevance to content learning. | |

*Source:* Excerpted from *Scoring Guide for Lesson Plans That Use Technology Resources*, available online at http://www.ncrtec.org/tl/sgsp/lpsg.htm. Copyright © 2001 Learning Point Associates and Bernajean Porter Consulting. Used with permission of Learning Point Associates.

FROM THE CLASSROOM

The teacher comments below address issues from this chapter.

Differentiation

This year at my school the staff has focused on differentiation of instruction to ensure all students reach the standards. All students are involved in the same goal, but how the teacher helps individual students reach the goal is different. Using differentiation in my class has helped more students master benchmarks versus having modified lessons for different students. My ELL students need to learn to write a persuasive paper—at the computer is a template that "guides" them through the process, prompting them with specific questions to answer in their paper. Other students may be working at their desk brainstorming, drafting, peer sharing [w]hile other students may be using a graphic organizer to organize the content of their writing. When lessons are modified—some students are then not necessarily working at reaching a standard. The technology available in the classroom helps develop differentiated learning opportunities. (Jean, sixth- grade teacher)

Balance

We have all heard the advantages and disadvantages of these tools. The concern I heard most often—how will they ever learn (math facts, spelling), students are too dependent on the tools and don't try on their own first. Teachers need to remember: What is the goal or objective of a lesson, how can the goal be reached—strategies/skills/tools needed to reach the goal, what support does a student need—scaffolding, language, drill. And, remember the assessment must be integrated in the learning. I prefer that my students first try to solve problems using their thinking power—then use the tools available—spell check, calculator, resources, each other, teacher. (Jean, sixth-grade teacher)

In regards to students using [chat] with friends, has anyone noticed a decline in students' abilities to write correctly with grammar and spelling? IRC has given rise to an entire new subculture language that kids are using for hours on end. I actually had a middle school student turn in homework with IRC lingo. To her, the word "for" is spelled "4," and that's how she turned in her paper. Is anyone else seeing evidence of this in the school setting? (Barbara, third-grade bilingual teacher)

Content Tools

I'm locating Web sites for students and although it has taken me a long time to find some quality sites, I have finally found some that I can't wait to share . . . I found a cute site called Word Central. It has a lot of fun activities such as a rhyming dictionary, great kids' dictionary, games/activities, and message encoding/ decoding. Check it out at http://www.wordcentral.com/. Okay, one more. Kidshealth.com is awesome too. If you ever teach health or the human body, you've got to go here because there are cute videos, songs, and lots of informational articles for kids on all sorts of health-related issues: http://www.kidshealth.org.

(Jennie, first-grade teacher)

CHAPTER REVIEW

Key Points

Explain how content learning takes place.

Learning occurs when new information is attached to other information in the brain. If this information is isolated pieces of data, this process results in declarative knowledge. When declarative knowledge sorts into different webs of meaning, structural knowledge is the result. Procedural knowledge is the result of understanding connections among pieces of data. Procedural knowledge is the knowledge that allows students to take action. Teachers can and should support learners in every aspect of knowledge acquisition. Technology can help, but only if it is used wisely and arranged to fit the goals.

Explain the role of content learning in meeting other instructional goals.

Problem-solving, creativity, and other instructional goals depend, to an extent, on student mastery of content. However, content can also be learned through the process of reaching these goals.

Guidelines and techniques for using technology in content learning and teaching. Teachers must prepare their lessons in culturally responsive ways and use techniques such as differentiation and material adaptation to help all students access the content. They must also be flexible and observant enough to understand when students need a just-in-time lesson.

Analyze technologies that can be used to create opportunities for content learning for all students.

Teachers and students can employ a variety of electronic tools to support content learning, but they must also be aware of the content, nature, and viability of the tools that they use.

Describe and develop effective technology-enhanced content learning activities. Effective content learning activities are those that consider students' backgrounds and needs, are designed on the basis of how students learn, and use technologies that are appropriate, relevant, and necessary.

Create appropriate assessments for technology-enhanced content learning activities.

In order to create appropriate assessments, teachers can evaluate the design of their instruction and their evaluation measures through the use of scoring guides.

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# 5
# Chapter 3 Supporting Student Communication

Guidelines for every content area include communication as an essential component for meeting national standards. For example, ISTE's national education technology standards for students (NETS*S) address student mastery of technology communication tools, including being able to "communicate complex ideas clearly and effectively" (ISTE, 2017, n.p.). The math guidelines in the Common Core Standards have a complete section on math communication that emphasizes that students, for example, "communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning" (Common Core State Standards Initiative, 2017). Fine arts standards ask students to work together to develop improvisations; English focuses on communication skills, strategies, and applying language skills; the first goal of the foreign language and ESL standards is communication; and even PE standards support the goal of communicating about health. In every area, communication is understood to be a foundation of learning, and technology can help students to communicate with a variety of audiences for a variety of purposes by connecting them both online and off.

As you read the rest of the chapter, look for ways to use technology to help your students communicate and make connections.

Technology-supported communication projects can be fun and effective learning experiences for students and teachers, but, as this chapter will show, preparation is necessary.

## OVERVIEW OF COMMUNICATION AND TECHNOLOGY IN K–12 CLASSROOMS

In keeping with the premise of this text, before discussing how technology supports communication it is important to understand what communication is and why it is an important learning goal.

### What Is Communication?

Communication is a general term that implies the conveyance of information either one-way or through an exchange with two or more partners. Shirky (2003) identified three basic communication patterns that are still used in classrooms (also shown in Figure 3.1:

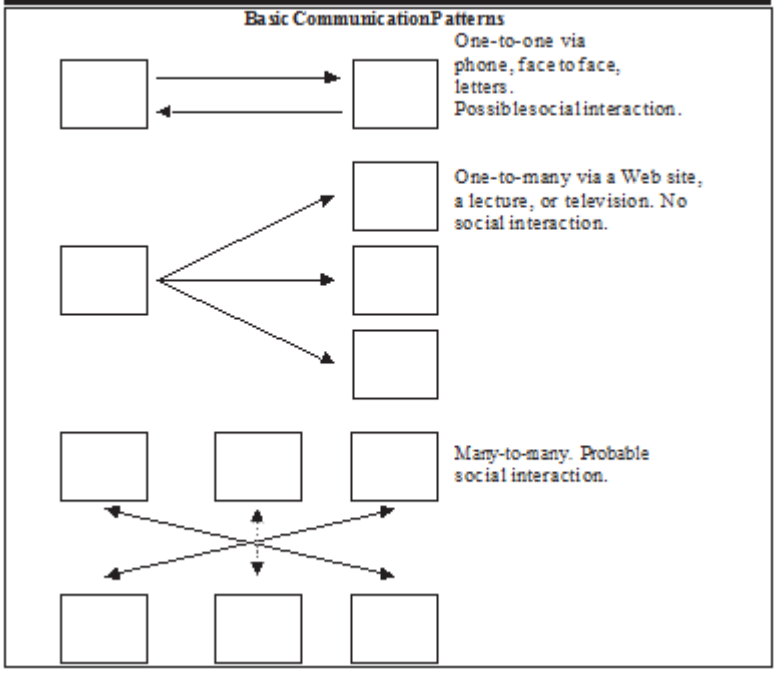
Point-to-point two-way (e.g., a two-person Internet chat or a phone conversation)

One-to-many outbound (e.g., a static Web site, a lecture, a TV show, a three-way phone conversation)

Many-to-many (e.g., a group discussion)

Learning takes place when the communication is based on true social interaction. Social interaction means that the communication is two-way, but it does not mean that participants are just giving each other information. Social interaction is communication with an authentic audience that shares some of the goals of the communication. It also includes an authentic task in which the answers are generally unknown by one or more (perhaps all!) participants. This kind of interaction requires interdependence and negotiation of meaning; in other words, during their communication participants ask for clarification, argue, challenge each other, and work toward common understanding. These features of communication can lead to effective learning by assisting students in understanding information and constructing knowledge with the help of others.

FIGURE 3.1 Basic Communication Patterns




Although educational software companies often advertise “interactive software,” true social interaction cannot occur with a software program because it cannot offer original, authentic, creative feedback or meet the other requirements for social interaction. Social interaction can, however, occur through technology (e.g., directly between two or more people via email, a cell phone, or other communications technology), around technology (e.g., students discussing a problem posed by a software program), or with the support of technology (e.g., teacher and students interacting about a worksheet printed from a Web site).

Social interaction, in other words, occurs between people. The interaction can be synchronous (in real

time during which participants take turns, such as during a phone call, face- to-face discussion, or chat) or asynchronous (not occurring at the same time, such as in an email conversation or letters—also known as “snail mail”). There are benefits and challenges for both types. For example, during synchronous communication while texting, learners can receive instant feedback, express themselves as ideas come to mind, and learn turn-taking and other skills.

During asynchronous communication, such as an email exchange, learners have more time to think about and format what they want to say and how they want to say it. In addition, they have time to consider ideas from other participants. They also have a record of the communication that they can refer to. For both types of student interaction to be successful, participants must learn and practice skills such as listening, speaking, writing, reading, and communicating nonverbally. A list of features of social interaction is presented in Figure 3.2.

- Is two-way
- Includes an authentic audience
- Can occur through, around, or with the support of technology
- Based on negotiation of meaning
- Offers authentic, creative feedback
- Synchronous or asynchronous
- Forms the basis for cooperation and collaboration

**FIGURE 3.2 Features of Social Interaction**

What Is Collaboration?

One type of communication that involves two-way interaction is collaboration. Collaboration is social interaction in which participants must plan and accomplish something specific together. Power (2016) notes that “Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (n.p.). Clearly, good communication based

in social interaction is central to collaboration.

## What Is Cooperation?

Although both cooperation and collaboration require social interaction—and technology can support both—they are not exactly the same processes. Cooperation generally implies that students have separate roles in a structured task and pool their data to a specific end, or, as Power notes, "Cooperation is accomplished by the division of labor among participants as an activity where each person is responsible for solving a portion of the problem" (n.p.). This is clearly different from collaboration, during which students work together in different ways from the planning stage on. Both collaboration and cooperation are beneficial to student learning.

## The Role of Technology in Communication

Technology, and in particular mobile technologies, can play a central role in learning through all forms of communication. For a useful overview of technology and collaboration, see Boyd (2016). In addition, research shows that students are more task-attentive and positively collaborating around and through the computer because the perceive that they have control, they receive immediate feedback, and they can collaborate with others in the "real" world (Boyd, 2016). Often, this is because the nature of the collaborative computer-based task is new, exciting, and requires different skills and language than previous tasks. It also might be because students feel that more individualized instruction and help are available. Research in these areas continues to shed light on how and why collaboration and social communication lead to learning.

In spite of what we have known about communication for years, classrooms teachers and students still often participate in a combination of the communication patterns and processes noted above—most commonly simple one-way outbound communication in the format of a lecture or presentation—but sometimes in variations of cooperative or collaborative tasks. Creating tasks in which students interact socially can be challenging, but teachers need to understand how to promote social interaction through technology-supported communication tasks in order to help students achieve. The discussion of communication tasks in the next section will assist in that challenge.

## Characteristics of Effective Technology-Supported Communication Tasks

Like tasks in other chapters of this book, communication tasks span a wide range of structures and content. As noted previously, effective communication is based on social interaction. Other components of effective communication tasks include those summarized in Figure 3.3 and explained here.

FIGURE 3.3 Components of Technology-Supported Communication Tasks

| Component | Focus |
|---|---|
| Content | Based on curricular goals and student needs. |
| Time | Appropriate for all students to finish their task. |
| Communication technologies | Help all students access the interaction. |
| Participants | Knowledgeable audience that can work with students at their level. |
| Roles | Everyone has a part to contribute. |
| Intentional focus on learning | Task and pacing help students stay on task. |

## Content

The content of communication tasks and projects must be based on curricular goals and students' needs.

## Time

Time is an important element and is also based on students' needs and on the task. Some classroom communications may take place very quickly, for example, giving instructions. Others, however, take longer, such as creating a joint bill to pass through a multi-school student congress. Typically, the more people involved and the more communication required, the more time the task may take. Also, if new technologies must be learned, time must be allotted for students to do so. In addition, students need time to think before responding in order to have the benefits of communication, and some students may need more time to formulate their communication than others.

## Communication technologies

Just as work toward other learning goals can take place without electronic technologies, so can communication. However, project participants outside the classroom may not be accessible in a timely manner without the use of electronic tools such as Skype, email, oovoo and other social media apps, or the telephone. Additionally, technology can make communication more accessible to learners with different physical abilities. For example, screen readers (discussed further in the Guidelines section of this chapter) that voice the text on a computer page can help students who do not see or read well to understand the content of a communication, and dictation software can help those who cannot type well to speak their messages while the computer translates them into text.

### Communication participants

There are a variety of people who can be called on to communicate with students. These include classmates and schoolmates (internal peers), peers from another school or area (external peers), parents, teachers, and content-area specialists (experts), and the general public. Lev Vygotsky (1962, 1978) and other researchers working in the sociocultural tradition show that participants are crucial to student success. These researchers posit that students learn by working through social interaction with the help of others on tasks that are slightly above their current level. Although the tasks could not be performed by the student alone, they are achievable with guidance and collaboration. Research in this area shows that what is learned with peers and others may transfer to other situations over the long term, even when students are later working individually.

### Participant roles

As noted previously, communication tasks work effectively when everyone has a part to contribute to the whole. Roles can be structured and assigned by the teacher or they can be chosen less formally by students within their groups. Students can each be responsible for a certain part of the content—e.g., a different set of years in the life of a famous person—and/or a specific part of the process, such as typist, illustrator, editor, and so on.

### Learning focus

Socializing, although certainly an important part of the communications process, will not help students learn content—students need to communicate about the concepts rather than just make conversation. Task structure and pacing can help students focus on the goals during tasks that require social interaction.

Student Benefits of Technology-Supported Communication

By communicating around or through technology in tasks with the characteristics listed above, students benefit in many ways. For those students who have access to relevant collaborators and technologies, benefits include

Not being limited by the school day or the school confines

Participating in individualized instruction

Feeling freer to exchange ideas openly

Being motivated to complete tasks

As they interact and negotiate meaning with others during communication tasks, students gain in language and content by

Having access to models and scaffolds

Thinking critically and creatively about language and content

Constructing meaning from joint experiences

Solving problems with information from multiple sources

Working with different points of view and different cultures

Learning to communicate in new and different ways, including using politeness tactics, appropriate turn-taking, and taking and giving constructive feedback

Working with an authentic audience

Expressing thoughts during learning

In addition, students working in teams can receive additional benefits. For example, teams tend to be better at solving problems, have a higher level of commitment, and include more people who can help implement an idea or plan. During collaboration, students learn and use communicative strategies. Moreover, teams are able to generate energy and interest in new projects. Especially important is that groups can be significantly more effective at reaching a goal than individual students would be. Because teamwork can offer students a chance to work toward their strengths supported by these scaffolds, students with all kinds of barriers to learning can benefit. The role of technology is to connect all students with a variety of audiences and interactants so that they receive the maximum benefit from their communication.

## THE TECHNOLOGY-SUPPORTED COMMUNICATION PROCESS

The process of supporting communication with technology, like the content learning process described in chapter 2, includes the basic categories of planning, developing, and analysis/ evaluation.

### Planning

During the planning stage, teachers should make sure that the process and outcomes are specific, relevant, and based on goals. Using objectives that state what the student will be able to do, to what extent, and in what way will assist in developing the rest of the lesson plan. For example, an objective that states, “The student will be able to describe five ways in which PCs and Macs differ” would be more effective in helping focus the lesson than a very broad objective that states, “Students should understand computers.” In addition to clear outcomes, the plan should include how and with whom students should interact. During the planning stage, teachers and students can decide whether technology is needed and if so, what kind of technology and how the chosen technology can meet the needs of students with different abilities. At this point, a review of other technology-supported communication projects might help teachers and students from forgetting something important that can make or break the activity.

During the planning stage the teacher should also find and evaluate potential participants and prepare them to understand the goals and responsibilities of the project. Many electronic lists and Web sites provide details of projects that teachers can join and allow teachers to post their own projects to find participants. iEARN (www.iearn.org) and Kidlink (www.kidlink.org) are two excellent project sites. Kidlink offers projects in many languages so that beginning English language learners can participate. Before they participate in the tasks, students should understand the writing conventions of their partners, especially if they are using a slightly different form of English (British English, for example). In addition, teachers should help students to figure out the language and content knowledge they need to grasp in order to communicate clearly and effectively during the project.

### Development

The planning stage is the most crucial for creating a successful project, but the teacher’s job does not end there. It is essential during the project development and implementation stage that the teacher observes students and makes changes in the project as necessary to meet student needs and curricular goals. Providing just-in-time skills lessons and coaching on team-building are also part of this stage.

### Analysis

Analysis of the project should be conducted by all participants so that different perspectives are gained. Participants should also take part in the evaluation of the task process and product. Finally, the teacher must provide appropriate closure, such as whole group discussion, a summary, or a debriefing about group process. More information on the assessment of communication projects is included in the assessment section of this chapter.

## Teachers and Technology-Supported Communication

The communication process, as outlined above, can pose any number of challenges for teachers and students, but teachers can make it easier by assuming different roles and giving their students opportunities to teach themselves and others. Technology-supported communication projects can be effective vehicles for providing such opportunities, as described here.

### The teacher's role in communication projects

Teachers can take different roles in communication projects depending on the needs of their students. In some instances, for example, with younger or less-English-proficient students, the teacher may provide more help, resources, and structure and fewer truly collaborative tasks. In other projects the teacher may be more of an active facilitator in that she or he

Provides structure through choices and limits

Scaffolds and models

Provides ongoing feedback

Addresses issues that come up with lessons on grammar or other skills

Helps students to deal with any problems that arise.

Some teachers may even act as "co-learners" in the task, collaborating with their students to construct meaning during a reciprocal experience. For example, teachers and students can co-learn while using Web-based resources to answer an essential question, as described in chapter 2. Because there is no "right" answer to the task, the teacher can work with students to decide "which is best" or "how it should be done."

Although teachers can take many roles, research shows that students are more willing to help and collaborate when the teacher is a facilitator rather than a guide or an all-knowing sage (see an explanation by Jones, 2015). Kumpulainen and Wray (2002) outlined four effective roles for the teacher in any project. These are shown in Figure 3.4.

The most important role for teachers in communication projects is to understand what their students need and to help them to meet the challenges of the task.

1. The teacher encourages students to share and initiate.
2. The teacher scaffolds and strategizes with students.
3. The teacher assists in shaping the rules that help everyone participate and understand different perspectives.
4. The teacher paces the task according to student needs and acts as a member of the learning community.

**FIGURE 3.4 Roles for Teachers**

Challenges for teachers

Potential challenges for teachers and students in completing communications projects include:

Dealing with technical difficulties and non-responses from participants

Planning around school breaks

Making sure the distant partners understand the goals and procedures

Handling inappropriate message content

Providing just-in-time feedback and scaffolding

Group dynamics, or how people interact in a group, might also be an issue that teachers and students must deal with, regardless of the type of interaction. A number of research studies point out that

students' social status and other characteristics of group members might lead to breakdowns in participation and collaboration. The guidelines discussed in the next section suggest ways to overcome these barriers.

The more technology, distance, and participants involved in a communication project, the more challenges participants face in keeping the project going and making it an effective learning experience. That does not mean, however, that it is not worth the effort, but rather that careful planning and flexibility are necessary.

## GUIDELINES FOR SUPPORTING COMMUNICATION WITH TECHNOLOGY

### Designing Technology-Supported Communication Opportunities

Planning is crucial for the success of any communication project, regardless of how and whether it uses technology. Teachers must choose participants carefully, matched the project to standards and curriculum, and develop scaffolds to help students succeed. Two other useful guidelines for planning include considering the context and making safety a primary focus.

Guideline #1: Consider the context. Among the many resources communication tasks can employ, he has decided to use Google Docs as the most efficient way to give his students time to work on the project. Docs is a Web-based word processor to which teachers can control access and that they can set up to meet the needs of their specific students. Students can cooperate and collaborate with their teams and teacher from wherever they may be.

Teachers do have other choices of tools, but they should choose the most efficient for their physical contexts. In classrooms or schools that do not have reliable Internet access, participants still can access collaborators in other ways, such as through fax, phone, or letters, depending on the project timeline and the suitability of the technology to the project. If a classroom has only one computer, a project that is computer intensive for all students probably would not be efficient or effective.

Guideline #2: Safety first. Having children on the Internet is fraught with possible dangers, from accessing inappropriate Web sites to providing access to themselves; given only a child's name and general location, anyone can search the Web and obtain a map to the child's home. (For current statistics on Internet dangers and ideas about how to avoid them, see the excellent Enough is Enough site at http://enough.org/). Three aspects of safety must be considered to ensure that students are not harmed during communication and collaboration projects.

Classroom and school safety policy. Many schools and districts have a safe use policy for the technology in their school. Students and parents must read and understand the issues and deal with them swiftly if

the rules are broken. Teachers can model their rules on the “Rules for Online Safety” from the Safekids site (safekids.com). These rules for students include:

Never give out personal information or passwords, or send a picture without permission.

Tell adults if they come across information that makes them uncomfortable.

Do not meet online buddies without permission and a chaperone.

Do not respond to mean or uncomfortable messages.

Make rules with parents for going online.

Do not download anything without permission.

not hurt others or break the law.

Teach parents about the Internet.

Samples of other acceptable use policies are provided by the Family Online Safety Institute at https://www.fosi.org/.

Safe contexts. There are two issues in providing a safe context—with whom students interact and about what. This aspect is easier to control in face-to-face communication projects, but even within the classroom students can be subjected to harassment, inappropriate interaction, and other types of harm. Teachers should choose participants with whom they are familiar and whom they have evaluated carefully as being able to carry out the project within the boundaries set.

Safe tools. The Internet can be a scary place, and open-ended software and access are fraught with financial, privacy, legal, and other potential problems. Sites like Gaggle.net minimizes risks to students by providing Web-based email access focused on classroom use. It filters all messages and provides access to a variety of administrators and other participants, and it includes message boards that are monitored for content and chat rooms just for the school. The teacher can review all messages, and the system sends the teacher messages that might have inappropriate content. In addition, teachers can develop a list of inappropriate words that the software monitors. Teachers have the power to deny student access to their account and can block spam, or unsolicited, unwanted, or inappropriate messages, from external domains. Other safe tools include Kidmail (kidmail.net), www.epals.com, and other emailing options and filtering software such as NetNanny (http://www.netnanny.com/), that teachers can use, for example, to access and control what comes in and out of students’ email boxes (when they use these tools only, however).

Guideline #3: Teach group dynamics and team building skills. When students work face-to-face around or with the support of the computer they can use pragmatic cues such as facial expressions and gestures to help with understanding. It is sometimes difficult for students to work well in teams even

when they do have these cues. When students work through the computer without video support, these cues are absent, and therefore meaning has to rely solely on text. Lack of pragmatic cues can lead to miscommunication, misunderstanding, or worse, particularly if students from diverse backgrounds are participating. Therefore, students in all contexts need to develop or reflect on team building and group dynamics skills. In addition to clearly communicating the process and product expectations to students, teachers can help them learn to understand and work within groups by making sure that they can:

State their views clearly, and provide constructive criticism

Take criticism, intended or unintended.

Define their roles.

Deal with dissent; ask about miscommunications or misunderstandings (conflict resolution).

Use appropriate levels of politeness and language.

Develop an effective self-evaluation process.

Scenarios, modeling, and role-plays can be effective tools for developing these skills.

Guideline #4: Provide students with a reason to listen. Teaching students to listen actively to each other is no easy task. However, if they do not develop this skill, time on task is lessened and learning is less successful. Often teachers assume that students will listen because they are expected to, but this does not always happen. A great project that does not require students to listen to each other wastes some of the most effective learning opportunities. For example, a group presentation aimed solely at getting a grade from the teacher typically isolates the rest of the class from the knowledge being presented, especially if the topic of the presentation is the same for the group before and the group after. Likewise, chats, online discussions, or even emails that are too long, too unstructured, or in which it is difficult to find the relevant information can also allow students not to listen. Students are more likely to listen actively if they have a good reason to do so, and project structures can give that reason. For example, teachers can provide “listening” handouts on which students have to record some of the information for future use, or the teacher can assign students the role of presentation evaluator. In addition, authentic tasks in which outcomes are not all the same help students to listen. Figure 3.5 presents a summary of these guidelines.

FIGURE 3.5 Guidelines for Designing Opportunities for Communication

| Guidelines | Explanation |
|---|---|
| Consider the context. | Use technologies that work with the students, audience, and task. |
| Make safety a primary focus. | Review the classroom and school safety policies.<br>Choose safe technologies and a safe audience.<br>Work with parents. |
| Teach group dynamics and team-building skills. | Help students understand how to work effectively in groups with people of all kinds. |
| Provide students with a reason to listen. | Provide opportunities for students to listen actively for important information.<br>Make the information crucial to their success. |

## COMMUNICATION TECHNOLOGIES

Guidelines like those above are useful for developing communication tasks, but the right tool is essential. Egbert (2005) notes, "Many educators believe that technology's capability to support communication and collaboration has changed the classroom more than any of its other capabilities. In fact, it is how educators make use of that capability that can change classroom goals, dynamics, turn-taking, interactions, audiences, atmosphere, and feedback and create a host of other learning opportunities" (pp. 53–54). One crucial aspect of effective use is a tool that fits the tasks that they are requiring of their students. There can be many such tools, from MS Word's commenting feature, with which the teacher and peers can communicate about a student's writing, to Voicethread (voicethread.com/) and Jing (www.techsmith.com/jing.html), through which teachers and students can communicate both in text and orally.

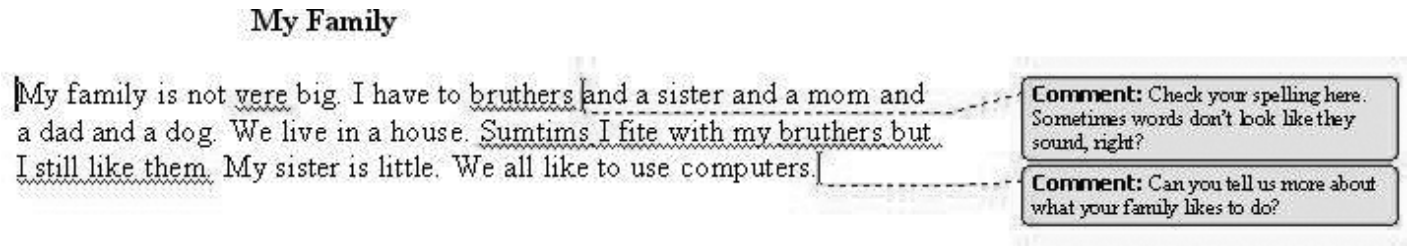



**FIGURE 3.6 MS Word Commenting**

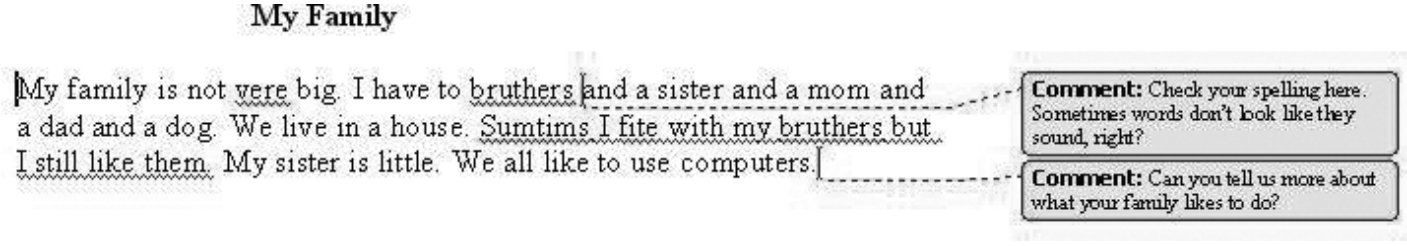

My Family
My family is not vere big. I have to bruthers and a sister and a mom and a dad and a dog. We live in a house. Sumtims I fite with my bruthers but I still like them. My sister is little. We all like to use computers.
Comment: Check your spelling here. Sometimes words don't look like they sound, right?
Comment: Can you tell us more about what your family likes to do?

**FIGURE 3.6 MS Word Commenting**

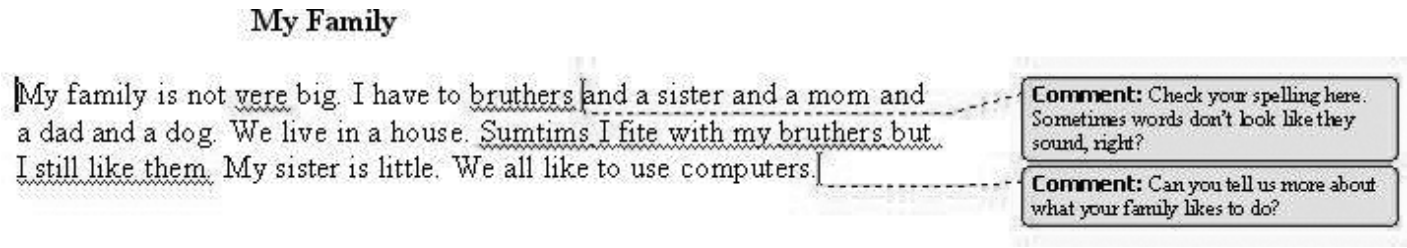



**FIGURE 3.6 MS Word Commenting**

The rapid growth in communication using digital support, particularly Facebook, Reddit, and other popular social media platforms, attests not only to the value of social connections, but also to the importance of those connections to life and learning. Wikis and weblogs are currently some of the more often-used classroom tools in social software, but often the older (and sometimes simpler) tools such as digital tape recorders and basic email can provide what teachers and students need, and these tools can be more accessible to a variety of users. For example, Sound Recorder software is included in every Microsoft operating system and Voice Memo is included with the Mac OS. However, as teachers understand more about the affordances, including privacy features and accessibility, that they can use in apps such as Facebook and Yahoo Groups, these apps may become more common for school use. Two-way interactive video and other communication technologies that are also used frequently for distance education or eLearning are described in chapter 8. Other tools are listed in this text's Teacher Toolbox.

Some communication tools are free (called freeware; this includes Google Docs); others are shareware. Shareware is software that users can test, and if they decide to keep it they pay a small fee to the developer. Typically, freeware and shareware are created by individuals or small groups of developers. Other tools for communication are commercial products sold by software companies. They vary in how easy they are to use and what they can do. Commercial products are usually more sophisticated and have many more features, but that does not always make them better for classroom use. As with any tool, teachers should check them carefully for characteristics that support effective and/or efficient learning before adopting them for classroom use.

Most teachers probably think of telecommunication tools as those mentioned previously, but software packages can both directly and indirectly support communication. Even common software packages such as word processors can be used for collaboration; as noted in chapter 2 and above, the "comment" function in Microsoft Word allows learners to comment on one an- other's work in writing inside the document. Voice (oral) annotations are also possible and are a good alternative for students who do not type well, who have physical barriers, or whose written skills are not understandable.

In addition, much of the software from educational software companies such as Tom Snyder Productions/Scholastic (www.tomsnyder.com) is based on student collaboration. Packages such as the Inspirer (geography/social studies), Decisions, Decisions (government/social studies), and Fizz and Martina (math) series are aligned with content-area standards and have built-in mechanisms for collaboration. The teachers' guides that accompany these software packages also include ideas about

how to make the collaboration work for all learners, including English language learners. Perhaps essential for some contexts, much of the Tom Snyder software is intended for students to work with as a class in the one-computer classroom. However, more important than how the software connects learners is why and with whom learners connect. Much content-based software guides students into predetermined conclusions, and teachers must take care to make sure that those conclusions are equitable and socially responsible.

## LEARNING ACTIVITIES: COMMUNICATION TASKS

Communication opportunities are mentioned throughout this book because learning results from the interaction that takes place during these opportunities, regardless of the task goal. Many of the activities in this book have a communication component. Although examples of telecommunications projects abound, there are fewer examples of communication projects in which students work around and with the support of technologies. However, in addition to the tools listed previously, Web sites and other Internet tools provide an amazing number and variety of opportunities for students to communicate around, with, and through technology.

This section presents examples of communication activities. Each of the examples described begins with a content-area standard as its goal. All examples also address the technology standard that students learn to communicate effectively with and to a variety of audiences. Audiences for the examples are included; an internal peer refers to a classmate or schoolmate, and an external peer is someone in another school, district, region, or country. Teachers are not included as participants in these examples because it is a given that much classroom communication will be aimed at or filtered through them.

In the activities, students work around, with the support of, and through the computer. As you read the activities, reflect on how the guidelines from this chapter might be applied in each case and which technologies might be used to support the learning opportunities.

| Standard: Science—Students develop understanding of organisms and environments. | |
|---|---|
| Participants | Activity |
| Internal peers | Work together to build an electronic text on animal habitats. Present the text to students in other grade groups to help them prepare for a test. |
| External peers | Complete a series of science mysteries using the format that Mr. Finley developed. Use mystery animals from another region of the world as the subjects of the project. |
| Experts | Complete a habitat WebQuest (search at webquest.org) and then have the products evaluated by local scientists or zoo personnel. |
| General public | Prepare the lesson on animal habitats located at http://school.discovery.com/lessonplans/programs/habitats/. Develop the Mystery Animals extension of the lesson and post the mysteries to the Web for others to guess. |

Science Example: Mad Sci (http://www.madsci.org/)

In addition to features such as links, lessons, “random knowledge,” the Visible Human tour, and lots of fun experiments, the Mad Sci site provides Ask-a-Scientist (http://www.madsci.org/submit.html). Be sure that students understand the rules of use, published clearly on the site, before they pose questions to the experts. Students should also learn how to write succinct, pointed questions that experts can answer in a short amount of time. The people who run the site and its policies and procedures are clearly stated, making it easy for teachers to decide whether this is a safe site and how it can best be used. Use the information in “Setting Up an Ask the Expert Service” to create your own expert site; this might be a particularly useful experience for secondary students in specific disciplines.

| Standard: Social studies—Work together to promote the values and principles of American democracy. | |
|---|---|
| Participants | Activity |
| Internal peers<br>External peers<br>Experts<br>General public | Work with internal peer teams using a worksheet and Web site to find out more about local democracy. Take one political organization or body (who serve as experts) to interview, or each team member can gather information on one aspect of each organization, by email, telephone, or face to face. Then create a report to share with the rest of the class. Build posters to hang in town so that the general public is also informed. Work with external peers to compare and contrast community decision-makers across states, regions, and countries. |

Social Studies Example: Voices of Youth (http://www.unicef.org/voy/)

Current discussions (2017) on this site supported by UNICEF include “The Hidden Victims of the Migration Crisis,” Where Do I Belong,” and “Young Bosses?,” posted by students from around the world and available for discussion both on the site and through Twitter.

| Standard: Math—Organize and consolidate mathematical thinking through communication. Communicate thinking coherently and clearly to peers, teachers, and others. | |
|---|---|
| Participants | Activity |
| Internal peers | Collaborate in groups around one computer as the teacher facilitates Fizz and Martina's Math Adventure (Tom Snyder Productions/Scholastic). Communicate answers and understandings as the work progresses. |
| External peers | Work on a math activity, such as The Cylinder Problem, at http://mathforum.org/brap/wrap/elemlesson.html. Email understandings and questions to peers who are also studying this problem. Together, the groups come to solutions and conclusions. |
| Experts | Work with family members to perform the same calculations. Use the Family Math Activity provided by Math Forum at http://mathforum.org/brap/wrap/familymath.html. |
| General public | Write word problems and challenge members of the public to solve them, through email, a Web site, or public mail. |

Math Example: The Globe Program Student Investigations (http://www.globe.gov/)

At this site, teachers and their students can join any number of collaborative student investigations with peers from around the world, submit reports and photos of their projects, and discover information from other projects.

Additional Examples

| Standard: English—Students adjust their use of spoken, written, and visual language to communicate effectively with a variety of audiences for different purposes. | |
|---|---|
| Participants | Activity |
| Internal peers External peers Experts General public | Write a persuasive essay collaboratively. Share the essay with internal and external peers for feedback and get help with content from experts during the process. Publish a hard copy of the paper at the school or a digital copy in an electronic forum for public consumption and response. |

Standard: Physical Education—Demonstrate the ability to influence and support others in making positive health choices.

| Participants | Activity |
|---|---|
| Internal peers | Create and present a multimedia presentation for younger students about some aspect of health and fitness. |
| External peers | Through email, build an argument that uses online and offline resources to convince peers to try your favorite healthy recipe. |
| Experts (doctors) | Check WebMD.com or other sites for advice or information about a health issue and then discuss any questions, especially about the answers you found, on Ask a Doctor at http://www.mdadvice.com/ask/ask.htm. Use the findings to create a persuasive essay or letter to the editor. |
| General public | Develop Web pages that provide feedback about healthy eating, or create a survey that provides results about how healthy a particular diet is. |

| Standard: ESL—Use English to participate in social interaction. | |
|---|---|
| Participants | Activity |
| Internal peers | Work on a project using Tom Snyder Productions/Scholastic's Cultural Reporter books and templates. Conduct interviews, library research, and use other resources to find answers to a question about American culture. |
| External peers | Use computer-mediated communication to meet and converse with peers from around the world. |
| Experts | Go to Dave's ESL Café (http://www.eslcafe.com/) to ask questions about grammar and other language and culture issues. |
| General public | Create an electronic forum using Blogger or another platform to discuss idioms, jargon, and colloquial speech from all over the United States. Ask follow-up questions to contributors and thank them for their participation. |

Multidisciplinary Example: iEARN (http://www.iearn.org/)

One of the most popular sites on the Web for "collaborative educational projects that both enhance learning and make a difference in the world," the International Education and Resource Network (I*EARN) provides three different types of opportunities for students and schools—to join an existing project, to develop a project relevant to their curriculum, or to join a learning circle. Projects span content and skill areas and include students from countries around the world. Projects on topics from folktales to funny videos and values to sports incorporate every subject area and result in a product or exhibition that is shared with others.

Communicating in Limited Technology Contexts

Benefits of using the kinds of ready-made projects provided by I*EARN, described above, include the support that is available, such as tips for helping participants understand each other, software that is accessible for learners with slow Internet access, and offline work for students in limited technology contexts.

Of course, there are classrooms around the world that do not have access and cannot participate in the electronic portion of these amazing technology-enhanced projects. That does not mean that they are not valuable as interactants. Teachers and students need to reflect on how to communicate and collaborate with peers regardless of their access to digital technologies.

Other Communication Projects

Some particularly powerful learning experiences based on communicating come from follow-alongs, in which classes interact with experts and adventurers around the world as they travel through space,

bicycle around the world, compete in the Iditarod, or make discoveries along the Amazon River. For examples of these and other communication projects, teachers can conduct a Web search with the terms “student examples” and “telecommunications projects.” This search will provide more responses than it is possible to review. To make the search more useful, add a content area, grade level, and other details to the search. Teachers do not necessarily need to develop projects from the ground up—there are plenty of project frameworks and examples for teachers to join or use in developing their own. Of course, teachers should give credit to the originator of the lesson or project and modify it to fit their specific contexts.

## ASSESSING COMMUNICATION TASKS: RUBRICS

The wide variety of communication activities noted in the previous section, along with the diversity in student skills, goals, and needs in every classroom, indicate that student achievement during communication tasks should be assessed at different times in different ways. This section describes ways to assess student process and outcomes during communication tasks. Other assessments throughout this text may also be applicable to the assessment of communication tasks— as you read other chapters, keep this in mind.

### Planning

In the planning stage, teachers can check on the effectiveness of the project design using the Lesson Analysis and Adaptation Worksheet (found in the Teacher Toolbox).

### Development

During the project, teachers can use formative assessment tools, or tools that help students understand their process and provide feedback to help them work better. Formative assessments include teacher observations. Teachers can make observations using personal digital assistants or other portable technologies in conjunction with checklists like the inclusion checklists from http://www.circleofinclusion.org/ or a teacher-made checklist that notes student progress toward individual goals. Student self-reports—for example, “a list of what I accomplished today” or “a question that came up today”—can also help to make sure that students are on task and that the project is moving toward the goals effectively.

### Analysis

To make a summative evaluation, in other words, to assess outcomes or products, it is important to strike a balance between team outcomes and individual accountability. Peer assessments, based on team participation or progress, are often useful for evaluating individual performance, and if the project consists of online segments, teachers can collect copies of the discussion and other participation examples. Another option for peers is to keep an "I did/he did/she did" list (McNinch, personal communication, 2005). Students list what each team member contributed to the project. The teacher can cross-reference the lists and observations and have a pretty good idea of what was done by whom and perhaps even what affected the group dynamics.

Rubrics are also useful to assess product and process. A rubric provides both criteria for evaluation and the performance levels that should be met. Rubrics also help students to understand what is expected of them throughout the project. Teachers can find many free rubric-makers and sample rubrics on the Web. Some guide the teacher through the whole rubric construction process (e.g., Rubistar, rubistar.4teachers.org/), and others supply different rubrics for different types of tasks (e.g., Teachnology, teachnology.com/web_tools/rubrics/).Even if teachers and students use these technologies, they still need to understand how and why to create assessment rubrics. Prentice Hall School Professional Development's Web site (www.phschool.com/) sums up the following guidelines for rubric development:

Specify student behaviors that you will observe and judge in the performance assessment.

Identify dimensions of the key behaviors to be assessed. If the assessment tasks are complex, several dimensions of behaviors may have to be assessed.

Develop concrete examples of the behaviors that you will assess.

Decide what type of rubric will be used: one that evaluates the overall project, one that evaluates each piece of the project separately, a generic rubric that fits with any task, one created specifically for this task, or a combination.

Decide what kind of outcomes you will provide to students: checklists, points, comments, or some combination.

Develop standards of excellence, or criteria, for specified performance levels.

Decide who will score each performance assessment—the teacher, the students (either self-scoring or peer scoring), or an outside expert.

Share scoring specifications with other stakeholders in the assessment system—parents, teachers, and students. All stakeholders must understand the behaviors in the same way.

Rubrics are best understood by students when they have a hand in making them. Regardless of who makes the rubric, students must be able to access the criteria and have clear examples of performance

levels throughout the project. For example, if a teacher provides handouts and mini-lessons during a project, that teacher can use both the completed handouts and observations to give students feedback on their progress. To measure the outcomes, the teacher can develop a rubric with his students based on the objectives of the project. They will decide together that the important criteria for the project. The teacher can then work with the students to clarify each level of performance (excellent, good, fair, poor) and to help them use the rubric to assess their own performance.

If students are safe and well prepared, communication around, through, and about computers can help them to achieve in a variety of ways. It can also support 21st-century skills such as critical thinking, the topic of chapter 4.

FROM THE CLASSROOM

Classroom Interaction

Students involved in group projects will have a positive experience with writing, reading, and speaking English when the emphasis is placed on the group versus on the individual. Students practice reading, writing, and speaking English through brainstorming of ideas. Through peer editing and revising students are involved in using/learning language. Using technology to locate information and publish group activities encourages careful use of reading strategies, following directions, creative thinking to solve problems, and respect and constructive behavior to accomplish a task. As the classroom setting becomes a group of students accustomed to sharing common interests and pursuits, mutual respect, trust, acceptance, responsibility, and self-evaluation will be fostered. These are lifelong skills needed to function productively in any society. (Jean sixth-grade teacher).

While I think that cooperative learning has its place, I am not that enthralled with it. I disagree with always giving kids a specific job to do in a group activity. I think the student learns more from collaborative learning, when he or she is involved with the whole process. I like the idea better of all members sharing ideas to accomplish a task. I don’t think all members of a cooperative learning team learn as much as they could because they are limited by their specific tasks. For example, how much learning does the timekeeper really get out of an activity when all he or she is doing is just keeping track of the time? Sure the timekeeper watches, but the timekeeper could be watching a demonstration in the front of the room and learn from observing. I think we want our kids to be actively involved. We want each one of them to be using as many senses as possible when learning. When we purposefully limit them to using only a few senses, I think we are shortchanging them. Collaborative learning, on the other hand, requires all students to be active participants in the learning. Students share in the total experience, and I feel much more learning can take place. I am not saying that cooperative learning does not have any place in the classroom. I think there are times when what we want to teach is

accomplishing a task with each member of the group helping with just one role. In those cases I think cooperative learning is great. For the most part, however, my vote would be with collaborative learning. (Susan, fifth-grade teacher).

### Safety

Our students have to get a form signed by their parents allowing them to use the Internet. It also acts as a contract stating that the student will follow the school guidelines on Internet use. Furthermore, their core teacher has to sign the form, agreeing with the students and the parent that the student will use the internet for appropriate, scholastic reasons. So, in order for the student to have Internet use, not only does the parent have to sign the form but the student and the teacher as well. (Adrian, sixth-grade teacher)

### Follow-Along

Last year I participated with my class in a wonderful Web-based project where a group of teachers registered as part of Iditarod. We shared general information about our classes: age, demographic, geographic location, etc. This information was posted in a list-serv. There were suggested activities and opportunities for classes to interact with one another as we researched the history of the Iditarod and followed the race itself in March. Each of my table groups picked a musher to follow through the race. They emailed the musher—all but one group received personal email responses from the musher. There are tons of resources that accompany the project, some submitted by teachers, others by the Web master. It connected the kids with real action following the daily postings of the Iditarod race. (Jennie, first-grade teacher).

## CHAPTER REVIEW

### Key Points

Define communication, collaboration, and related terms.

The boundaries between communication, interaction, cooperation, and collaboration can be blurry. In the simplest sense, “communication” can be seen as the umbrella term. Communication can be one-way or two-way. Communication includes interaction, meaning give-and-take between participants. Interaction can be cooperative or collaborative, both of which require negotiation of meaning. Interaction can also be asynchronous or synchro- nous. Both types of interaction have advantages and

disadvantages.

Describe the communication process and explain how communication affects learning.

The communication process includes planning, developing, and analysis/evaluation. Each step is important for communication tasks to be effective. This chapter has described the importance of social interaction to learning. Social interaction provides scaffolds for language and content, which help move students to new understandings. Benefits include exposure to new cultures, language uses, views of content, and the use of critical thinking skills.

Discuss guidelines and techniques for creating opportunities for technology-supported communication and collaboration.

Choosing the best technology for the task and making sure that students are safe while using the chosen tools are paramount objectives for successful projects. Most important for such projects is that tools can be used to facilitate the language and content acquisition of all students, from differently abled to differently motivated. In addition, teaching group dynamics and team building skills and giving students reasons to listen help avoid communication breakdowns during projects that rely on communication. Fair, useful, and ongoing assessment facilitates students' understanding of their roles, their progress, and the effective- ness of the project. Careful planning that includes these strategies can support effective learning experiences.

Analyze technologies that can be used to support communication, including MOOs, email, chat, blogs, and wikis, Facebook, Instagram, Snapchat, WhatsApp, Google Hangouts.

People probably think of communication tools as technologies that students can use to connect through. However, students can also connect around and with the support of technologies such as stand-alone software and Web sites. The technology must be appropriate for the goal, support the intended communication, and be accessible to all participants.

Describe and develop effective technology-enhanced communication activities.

Teachers can work with students to provide learning experiences that address the needs of a wide range of learners while addressing standards and curricular requirements by:

Using the planning, development, and evaluation processes outlined in the chapter

Keeping in mind student needs and the physical context

Focusing on crucial language and content goals

This chapter's activity examples provide only a small sample of a very large set of interesting and fun projects that involve communication around, supported by, and through technology. The true scope of projects that include some kind of communication is beyond the ability of this book to address. Teachers

can use existing resources and their own (and their students') knowledge and imagination in developing relevant tasks that achieve learning goals.

Create appropriate assessments for technology-enhanced communication tasks.

A wide range of tools is available for teachers to use in assessment. One tool that can help in a variety of contexts is a rubric-maker. In addition, ready-made rubrics and checklists are available across the Web. Understanding how to develop and use rubrics is an important step in creating appropriate assessments.

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# 6
# Chapter 4 Supporting Students' Critical Thinking

Critical thinking is fundamental to learner achievement in all subject areas. There are a great number and variety of standards that students are expected to meet using critical thinking skills such as analyzing, evaluating, and assessing; this is because critical thinking is essential for students to lead productive lives. Almost 30 years ago, Facione (1990) argued that critical thinking is also necessary for societies to hang together, stating, "Being a free, responsible person means being able to make rational, unconstrained choices. A person who cannot think critically, cannot make rational choices. And, those without the ability to make rational choices should not be allowed to run free, for being irresponsible, they could easily be a danger to themselves and to the rest of us" (p. 13). That sentiment is even more applicable in the age of the Internet and world unrest as humans prepare for an unknown future.

## OVERVIEW OF CRITICAL THINKING AND TECHNOLOGY IN K–12 CLASSROOMS

In order to implement technology use with a learning focus, teachers need to understand critical thinking before attempting to support it with technology.

### What Is Critical Thinking?

Critical thinking skills refer to abilities to be open-minded, mindful, and analytical, and to evaluate, question, reason, hypothesize, interpret, explain, and draw conclusions (Ennis, 2012). A simple way to define critical thinking is the ability to make good decisions and to clearly explain the foundation for those decisions. When using technology, being able to think critically allows one to:

Judge the credibility of sources.

Identify conclusions, reasons, and assumptions.

Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence.

Develop and defend a position on an issue.

Ask appropriate clarifying questions.

Plan experiments and judge experimental designs.

Define terms in a way appropriate for the context.

Be open-minded.

Try to be well-informed.

Draw conclusions when warranted, but with caution. (Ennis, 1993, p. 180)

To some extent all humans, even very young children, continually think critically to analyze their world and to make sense of it. However, most people's skills are not as well developed as they could or should be, and there is a clear link between critical thinking and student success. Scholars agree, however, that schools are not the most productive learning environments for critical thinking, and that schools need to take a stronger focus on critical thinking.

Critical thinking is part of a group of cognitive abilities and personal characteristics called higher order thinking skills (HOTS). These skills also include creative thinking (chapter 5) and problem solving (chapter 6). This list of cognitive skills is based on Bloom's well-known Taxonomy of Educational Goals (Bloom, 1956). Bloom's first three competencies—knowledge, comprehension, and application—are generally equated with the acquisition of declarative knowledge (discussed in chapter 2). The second three competencies—analysis, synthesis, and evaluation—are generally considered critical thinking or higher order skills. Figure 4.1 presents an example of critical thinking skills from Bloom's taxonomy and the types of technology-enhanced tasks that might support them. Forty-five years after Bloom's Taxonomy was published, Anderson and Krathwohl (2001) revised it to add a "metacognitive knowledge" category and to make it easier for teachers to design instruction that requires critical thinking. Excellent resources for using the revised taxonomy are available from teachthought at http://www.teachthought.com/pedagogy/50-resources-for-teaching-with-blooms-taxonomy/ and many other sources on the Web, including Pinterest (e.g., the poster at

https://www.pinterest.com/pin/287597126178595755/).

FIGURE 4.1 Higher Order Thinking Skills from Bloom's Taxonomy

| Competence | Skills Demonstrated | Sample Technology- Enhanced Tasks |
|---|---|---|
| Analysis | Seeing patterns.<br>Organize parts.<br>Recognize hidden meanings.<br>Identify components. | Students brainstorm about the information they need and the questions they need to ask and make a chart using Inspiration software. |
| Synthesis | Use old ideas to create new ones.<br>Generalize from given facts.<br>Relate knowledge from several areas.<br>Predict, draw conclusions. | Students gather facts from electronic and paper resources about alligators, sewers, and New York and input them into a database. They arrange and study the data to suggest conclusions. |
| Evaluation | Compare and discriminate between ideas.<br>Assess value of theories, presentations.<br>Make choices based on reasoned argument.<br>Verify value of evidence.<br>Recognize subjectivity. | Students evaluate their argument and conclusions about alligators in the sewers by interacting with online experts before they present their argument to the class. |

Source: From Benjamin S. Bloom, Taxonomy of educational objectives. Published by Allyn & Bacon, Boston, MA. Copyright © 1984 by Pearson Education. Adapted by permission of the publisher.

Critical thinking has been central to education since the time of Socrates (469–399 B.C.E.). The focus of the Socratic method is to question students so that they come to justify their arguments; this teaching strategy is still used in many classrooms to foster critical thinking. Edutopia (https://www.edutopia.org/) provides many resources for Socratic/ critical thinking. Critical thinking software can also provide tasks that require critical thinking and prompts to help students understand how to come to effective decisions. Regardless of the tool that students use to support their critical thinking, it is important to note the crucial role of critical thinking skills both in school and out. In fact, since Socrates, philosophers throughout history such as Plato, Francis Bacon, Rene Descartes, William Graham Sumner, and John Dewey have emphasized the need for students to think critically about their world.

More specifically, scholars note that critical thinking is one foundation for learning, in part because all of the learning skills are interdependent and, as Paul (2004a) points out, "everything essential to education supports everything else essential to education" (p. 3). For example, as students consider how to decide whether they can believe everything they read on the Internet, they use a variety of skills to

Understand basic content.

Communicate among themselves and with others.

Think creatively about resources.

Assess the veracity of the information they come in contact with.

Produce a well-supported conclusion.

In other words, they must think critically throughout the process as they develop other learning skills.

It is also clear that critical thinking is used in all areas of life as we learn and experience. Making a good decision about whether to buy a laptop or an iPod, and then which model, requires research, assessment, evaluation, and careful planning, just as deciding what to eat for dinner or how to spend free time does.

Although there may be discipline-specific skills, general critical thinking skills may apply across disciplines and content areas (Ennis, 2011a; McPeck, 1992). For example, Stupple, et al (2017) note that critical thinking skills test scores correlate positively with college GPA. Although this is not a causal relationship (in other words, the research does not show that effective critical thinking causes a high GPA), there appears to be something about students who can think critically that helps them succeed in college. In addition, the processes that students use to think critically appear to transfer or assist not only in the reading process but in general decision- making. However, experts disagree to what extent this happens. Some researchers believe that much critical thinking is subject- or genre-specific. Nonetheless, all agree that it is crucial to help students hone their critical thinking abilities, and many believe that technology can help by providing support in ways outlined throughout this chapter.

In addition to the lessons presented in this chapter based on these ideas, other chapters of this book present ideas and activities that involve critical thinking either implicitly or explicitly. As you read through the text, see if you can find those examples.

## Critical Thinking and Media Literacy

Critical thinking, as defined in the previous section, is especially important because media, particularly television and computers, is increasingly prevalent in the lives of K–12 students. Students have always needed to have general information literacy, or “knowing when and why you need information, where to find it, and how to evaluate, use, and communicate it in an ethical manner” (CILIP, 2007). However, students who are faced with a bombardment of images, sounds, and text need to go beyond information literacy to interpret and assess (in other words, think critically about) information in new ways. In other words, they must be media literate.

In general, media literacy means that students are able not only to comprehend what they read, hear, and see but also to evaluate and make good decisions about what media presents. There are many variations on how to support students in becoming media literate. For example, the Center for Media Literacy, the world’s largest distributor of media education materials, recommends activities such as

tracing racial images in the media throughout history, exploring how maps are constructed (and asking questions like “Why does ‘north’ mean ‘up’?”), and challenging gender stereotypes in TV comedies. These activities are crucial because learners of all ages watch TV, and even kindergartners use the computer and may have access to the Internet. Much of what learners read, see, and hear they believe verbatim and share as truth with others, particularly if someone they see as an authority posts it. This occurs whether the message is intended as fact or not. To become more media literate, teachers and students need to learn and practice critical thinking skills that are directed at the ideologies, purveyors, and purposes behind their data sources. Most important, students must use the Internet responsibly and with the necessary skepticism; in particular, this includes investigative skills and the ability to judge the validity of information from Web sites.

There are many resources to help teachers and students to become media literate. One of the best is the Center for Media Literacy’s (CML) free K-12 resources (available from http://www.medialit.org/). The site presents a clear, theory-based definition and outstanding lessons based on the five core concepts of media literacy. The lessons and handouts focus on students learning to ask these five “key questions”:

Who created this message?

What creative techniques are used to attract my attention?

How might different people understand the message differently from me?

What values, lifestyles, and points of view are represented in, or omitted from, this message?

Why is this message being sent?

Another focus of the CML is the “Essential Questions for Teachers” that teachers should ask themselves:

Am I trying to tell the students what the message is? Or am I giving them the skills to determine what THEY think the message(s) might be?

Have I let students know that I am open to accepting their interpretation, as long as it is well substantiated, or have I conveyed the message that my interpretation is the only correct view?

At the end of the lesson, are students likely to be more analytical? Or more cynical?

During media literacy lessons, students use technology to construct their own critically evaluated multimedia messages. This site is an excellent resource both for teachers just beginning to explore media literacy and for those looking for additional pedagogically sound ideas and activities.

Another outstanding source of lessons, articles, and activities for K–12 is the Critical Evaluation section of Kathy Schrock’s Web site at http://www.schrockguide.net/critical-evaluation.html), as is the useful medialiteracy.com Web site (see Figure 4.2).

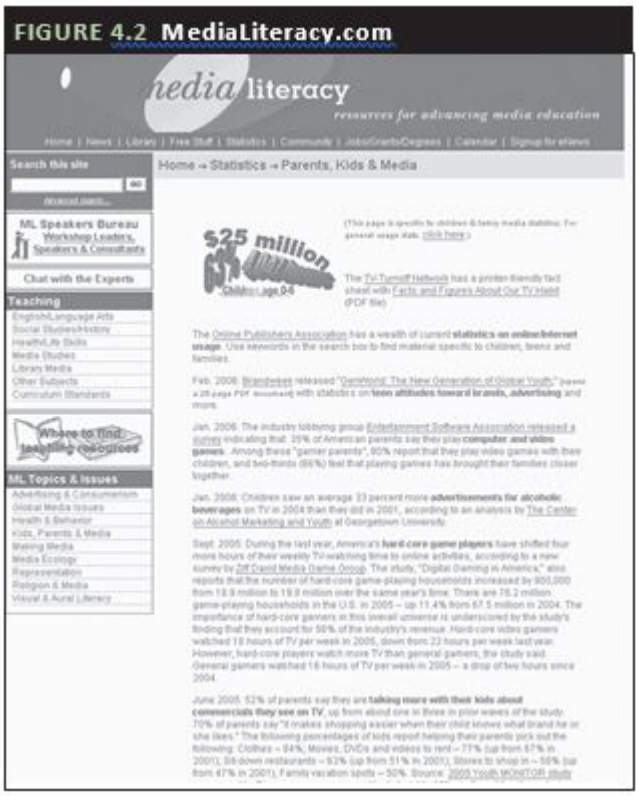



FIGURE 4.2 MediaLiteracy.com

*Source:* MediaLiteracy.com © 2007 by Susan Fraas Rogers.

Characteristics of Effective Critical Thinking Tasks

There are many ways to help students become media-literate critical thinkers. In general, effective critical thinking tasks:

Take place in an environment that supports objection, questioning, and reasoning.

Address issues that are ill-structured and may not have a simple answer.

Do not involve rote learning.

Provide alternatives in product and solution.

Allow students to make decisions and see consequences.

Are supported by tools and resources from many perspectives.

Help students examine their reasoning processes.

Teachers who want to promote critical thinking can employ the terms in Figure 4.3 in their student objectives and assignments. For example, if the objective is for students to analyze their use of technology, the teacher can ask students to contrast, categorize, and/or compare. If the objective is for students to evaluate technology use in schools, the teacher might ask students to defend, justify, or

predict. For more information and tools for secondary school, see the resources provided by the Critical Thinking Community at http://www.criticalthinking.org/pages/high-school-teachers/807 .

Student benefits of critical thinking

It should be clear from the previous discussion that good critical thinking skills affect students in many ways. Additional benefits that accrue to good critical thinkers include:

Better grades and/or performance on high stakes tests (Watanabe, 2015)

Independence

Good decision making

The ability to effect social change

Becoming better readers, writers, speakers, and listeners

The ability to address bias and prejudice

Willingness to stick with a task

**FIGURE 4.3 Critical Thinking Objectives**

- *Application:* apply, choose, construct, classify, demonstrate, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, schedule, sketch, show, solve, use, write
- *Analysis:* analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, investigate, question, separate, test
- *Synthesis:* arrange, assemble, collect, compose, construct, create, design, develop, devise, formulate, imagine, invent, manage, organize, plan, prepare, propose, set up, write
- *Evaluation:* appraise, argue, assess, attach, choose, compare, debate, decide, defend, estimate, evaluate, judge, justify, predict, rate, select, support, value, verify

*Source:* Adapted from Clark, 1999; Dalton and Smith, 1986; and Office Port, 2002.

Because critical thinking skills can be learned, all students, including those with different language and physical abilities and capabilities, have the potential to reap these benefits.

THE CRITICAL THINKING PROCESS

Although all students can benefit from critical thinking, no two people use the exact same skills or processes to think critically. However, teachers can present students with a general set of steps synthesized from the research literature that can serve as a basis for critical thinking. These steps are:

Review your content understanding/clarify the problem. Compile everything you know about the topic

that you are working on. Try to include even small details. Figure out what other content knowledge you need to know to help examine all sides of the question and how to get that information.

Analyze the material. Organize the material into categories or groupings by finding relationships among the pieces. Decide which aspects are the most important. Weigh all sides.

Synthesize your answers about the material. Decide why it is significant, how it can be applied, what the implications are, which ideas do not seem to fit well into the explanation that you decided on.

Evaluate your decision-making process.

Students can use this process as a foundation for discovering what works best for them to come to rational decisions. As outlined in the following section, teachers play a central role in sup- porting students in this process.

## Teachers and Critical Thinking

To support the critical thinking process with technology, teachers must first understand their roles and the challenges of working with learners who are developing their critical thinking skills. These issues are discussed here.

### The teacher’s role in critical thinking opportunities

Experts see the teacher’s role in critical thinking as being a model, helping students to see the need for and excitement of being able to think critically. In modeling critical thinking, teachers should:

Overtly and explicitly explain what they do and why.

Encourage students to think for themselves.

Be willing to admit and correct their own mistakes.

Be sensitive to students’ feelings, abilities, and goals and to what motivates them.

Allow students to participate in democratic processes in the classroom.

By modeling self-questioning and other strategies, teachers can help students to understand what critical thinkers do.

Teachers can also decide to teach critical thinking skills directly and/or through content— both are appropriate in specific contexts. Techniques that teachers can use to support critical thinking are

presented in Figure 4.4. Additional ideas are listed in the Guidelines section of this chapter.

**FIGURE 4.4 Common Techniques to Support Critical Thinking**

- Encourage students to find and use information from a variety of sources both online and offline.
- Provide support for information structuring (modeling with graphical organizers, for example).
- Assist students to compare information from different types of sources.
- Develop student debates.
- Allow students to reflect in different modes (e.g., writing, speaking, drawing).
- Help students make assumptions and values explicit.
- Use real experiences and materials.
- Involve students in creating and questioning assessments.

As Weiler (2004) notes, often students who are in a dualistic stage of intellectual development, in which they see everything as either right or wrong, will need a gradual introduction to the idea that not everything is so clear-cut. Rather than direct teaching of critical thinking, students can be led to understand this idea by encountering inexplicable or not easily answerable examples over time. For example, teachers addressing the urban myth of alligators in the sewers of New York might ask students to suggest what the sewers of New York might be like, and then to compare that to what they know about alligators' natural habitats. This might lead to a thoughtful consideration of whether alligators could survive in New York sewers. The teacher's role in this case is to ask questions to support student movement toward more complex reasoning.

Challenges for teachers

As the process above implies, learning to think critically takes time, and it requires many examples and practice across a variety of contexts. The school library media specialist is an excellent source for resources and ideas for teaching all aspects of critical thinking.

However, teaching students to think critically is not always an easy task, and it may be made more difficult by having students from cultures that do not value or promote displays of critical thinking in children in the same way as schools in the United States do or believe that it is the role of the school to do so. As many scholars point out, critical thinking in itself is probably not culturally biased, but the instruction of critical thinking can be. Teachers need to understand their students' approaches to reasoning and objection and to teach critical thinking supported by technology in culturally responsive ways (as mentioned in chapter 2) by:

Understanding and exploring what critical thinking means in other cultures

Avoiding overgeneralizing and recognizing salient cultural features of critical thinking during the process, particularly in the tools used

Taking into consideration the strengths and differences of students

GUIDELINES FOR SUPPORTING STUDENT CRITICAL THINKING WITH TECHNOLOGY

As with all the goals outlined in this text, there are many things for teachers to think about when deciding how to support critical thinking. Many of the guidelines in other chapters also apply. The guidelines here are not specific only to critical thinking.

Designing Critical Thinking Opportunities

Guideline #1: Ask the right questions. Research in classrooms shows that teachers ask mostly display questions to discover whether students can repeat the information from the lesson and can explain it in their own words. However, to promote critical thinking and reasoning, students need to think about and answer "essential" questions that help them to meet universal standards for critical thinking. These standards are directly related to analysis, synthesis, and evaluation (and sometimes to application), discussed above as characteristics of effective critical thinking tasks. For example, questions about clarity (Can you give me an example of …? What do you mean by… ?) ask students to apply their learning to their experience, and vice versa. Questions that focus on precision or specificity (Exactly how much… ? On what day and at what time did … ?) ask students to analyze the data more deeply. A question about breadth (How might___ answer this question? What do you think___would say about this issue?) might also challenge students to synthesize.

Whichever set of standards or objectives teachers decide to use, it is important that the teacher support the critical thinking process by providing scaffolds, or structures and reinforcements that help guide learners toward independent critical thinking. Critical thinking does not mean negative thinking, it means voluntary, justified, educated skepticism. Question formats and strategies for creating effective questions are provided by Kentucky Prism at http://www.kyprism.org, and see Cotton (2001) for still-relevant research on questioning and strategies to make it work in classrooms. On the Web, find lists of questions that can lead to critical thinking by conducting a search on the term "critical thinking questions."

Guideline #2: Use tasks with appropriate levels of challenge. Mihalyi Csikszentmihalyi (1997) and other researchers have found that the relationship between skills that students possess and the challenge that a task presents is important to learning. For example, they discovered that students of high ability were often bored with their lessons and that the balance of challenge and skills could be used to predict students' attitudes toward their lessons. Their findings indicate that activities should be neither too challenging nor too easy for the student. Teachers can use observation, interview, and other assessments to determine the level of readiness for each student on specific tasks and with different content. Teachers can then use student readiness to change the challenge that students face in a task by:

Changing the way students are grouped

Introducing new technologies

Changing the types of thinking tasks

Varying the questions they ask

Altering expectations of goals that can be met

Differentiation, a strategy for designing instruction that meets diverse students' needs (dis- cussed in chapter 2), can help teachers to provide tasks with appropriate levels of challenge for students.

Guideline #3: Teach strategies. Supporting critical thinking by modeling and asking questions is useful but not enough for all students. Good critical thinkers use metacognitive skills–in other words, they think about the process of their decision-making. The actual teaching of metacognitive strategies can have an impact on when and if students use them. To help students think about their thinking, teachers can prompt the students to ask themselves:

Did I have enough resources?

Were the resources sufficiently varied and from authorities I can trust?

Did I consider issues fairly?

Do all the data support my decision?

For English language learners (ELLs), this might mean teaching how to formulate and ask questions for clarity and specific information and to use relevant vocabulary words. One way this could hap- pen is to have ELLs create interview questions and interact with an external audience via email. Through the interaction and feedback from their email partners, the students could learn whether their questions were clear and specific and the vocabulary appropriate.

Guideline #4: Encourage curiosity. Why is the grass green? Why do I have to do geometry? Why are we at war? What are clouds made of? How do people choose what they will be when they grow up? Children ask these questions all the time, and these questions can lead to thinking critically about the world. However, in classroom settings they are often ignored, whether due to curricular, time, or other constraints. The Internet as a problem-solving and research tool (chapter 6) can contribute to teachers and learners finding answers together and evaluating those answers. However, if teachers stop learners from being curious, avoid their questions, or answer them unsatisfactorily, teachers can shut down the first step toward critical thinking.

A summary of these guidelines is presented in Figure 4.5.

**FIGURE 4.5 Guidelines for Critical Thinking**

| Guideline | Example |
|---|---|
| Ask the right questions. | Can you give me an example of ____?<br>What do you mean by ____?<br>What do you think_____would say about this issue? |
| Use tasks with appropriate levels of challenge. | Differentiate for different levels of students (see chapter 2 for more about differentiation). Give choices of tool, task, group. |
| Teach strategies. | Help students ask themselves questions about their learning processes. |
| Encourage curiosity. | Address and ask curious questions. |

CRITICAL THINKING TECHNOLOGIES

What Are Critical Thinking Tools?

Critical thinking tools are those that support the critical thinking process. Critical thinking instruction does not require the use of electronic tools. However, many of the tools mentioned throughout this book can be used to support critical thinking, depending on the specific activity. For example, word processing can help students lay out their thoughts before a debate, and concept mapping Web sites and software such as Inspiration (www.inspiration.com) can help students to brainstorm and plan their ideas. Likewise, the Internet can supply information, and databases and spreadsheets can help students organize data for more critical review.

This chapter presents tools that are specifically focused on building critical thinking skills. The following examples are categorized into:

Strategy software—content-free and structured to support critical thinking skills with student-generated content.

Content software—content is predetermined and strategy use is emphasized. Students typically read the software content and work out answers to questions.

Many other tools in these categories exist; those described here are some of the most popular, inexpensive, and useful.

Strategy Software

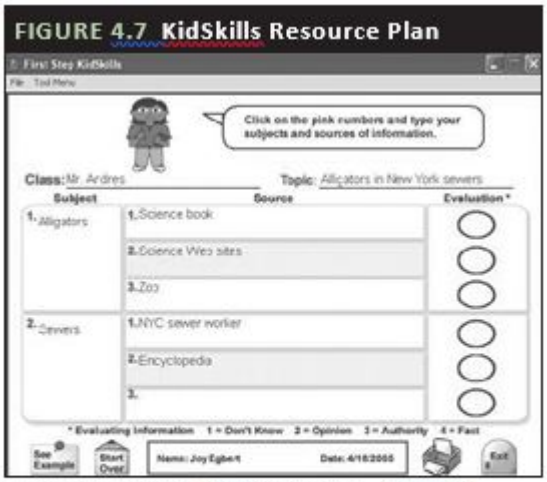
CMap v.3.8 (IHMC, 2005)

This software is easy to learn and use for third grade and up. The user double-clicks on the screen and inputs text into the shape that appears. Users can change the colors of the graphics and text to show different categories of reasoning such as objections, reasons, and claims. A very useful feature allows users to put text on the connecting lines to show the reasoning behind the connections they made. Figure 4.6 is an example map of the argument for and against alligators in the New York City sewer system. Download this software free from http://cmap.ihmc.us/.

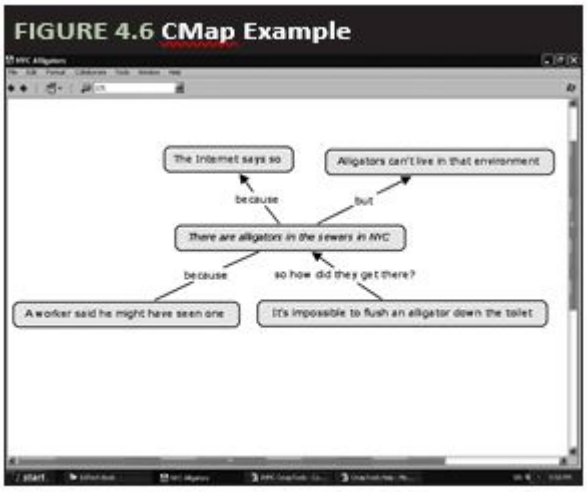
First Step KidSkills (Kid Tools Support System, 2003)

KidSkills is a free software package intended for students ages 7–13. Of the four sections, titled Getting Organized, Learning New Stuff, Doing Homework, and Doing Projects, the last has the greatest focus on critical thinking. This section has five activities: Project Planner, Getting

FIGURE 4.7 KidSkills Resource Plan




*Source:* Fitzgerald G., Koury, K., Peng, H., & Capel, C. (2003). First Step KidSkills [Computer Software and CD]. Columbia, MO; University of Missouri. Funded in part of U.S. Department of Education Grant #H033271. Available: http://kidtools.missouri.edu.




*Source:* Used with permission of Institute for Human & Machine Cognition.

Information, Big Picture Card, Working Together, and Project Evaluation. Each of the activities focuses on students combining information and printing or saving it in the form of a “card” or page. In the Project Planner exercise, students make a card that lists their question, topics for them to investigate, possible re- sources, and an evaluation of the resources (authority, fact, opinion, or don’t know). There is also a Second Step available, and resources and tips for use are provided on the Kid Tools Web site. Although intended for use with learners with learning disabilities or emotional/ behavioral problems, it is useful for all children and simple enough for students with limited English proficiency to understand and use, particularly because all instructions are presented in text and audio. Some teachers may find it too simple, but its simplicity is also part of its effectiveness.

Additional apps and tools are presented in the Teacher Toolbox for this text.

Content Software

BrainCogs (Fablevision, 2002)

A CD-based strategy program, BrainCogs helps students to learn, reflect on, and use specific strategies across a variety of contexts. The software employs an imaginary rock band, the Rotten Green Peppers, to demonstrate the importance of and techniques for remembering, organizing in- formation, prioritizing, shifting perspectives, and checking for mistakes. Although the focus is more on strategies to help students pass tests, the general strategy knowledge gained can transfer across subjects and tasks because it is not embedded in any specific content area. The software is accompanied by a video, posters, and other resources that function as scaffolds for diverse learners. The exercises, in addition to being entertaining and fun, employ multimedia (sound, text, and graphics) in ways that make the content accessible to English language learners and native English speakers with diverse learning styles. Available through http://www.fablevision.com/.

Mission Critical (San Jose State University)

This Web tool provides information and quizzes on critical thinking. Although intended for college students, the quizzes are simple and well explained and could be used at a number of different grade levels with support from the teacher. The site addresses arguments, persuasion, fallacies, and many other aspects of logic and critical thinking. The site begins at http://missioncritical.royalwebhosting.net/.

Choices, Choices: Taking Responsibility (Tom Snyder Productions/Scholastic)

Taking Responsibility helps students in grades K–4 work through a five-step critical thinking process:

Understand your situation.

Set goals.

Talk about your options.

Make a choice.

Think about the consequences.

Used on a single computer and facilitated by the teacher, the simulation in this software title provides a scenario in which two students have broken one of the teacher’s possessions; how- ever, no one else saw them. The class acts as the two students in the scenario. Through a series of decisions, the class must decide which actions to take and face the consequences of their decisions. There are 300 different ways that students can get through this software, so the consequences are not always clear- cut until

they are presented to students. Figure 4.8 presents the Taking Responsibility goal-setting screen.

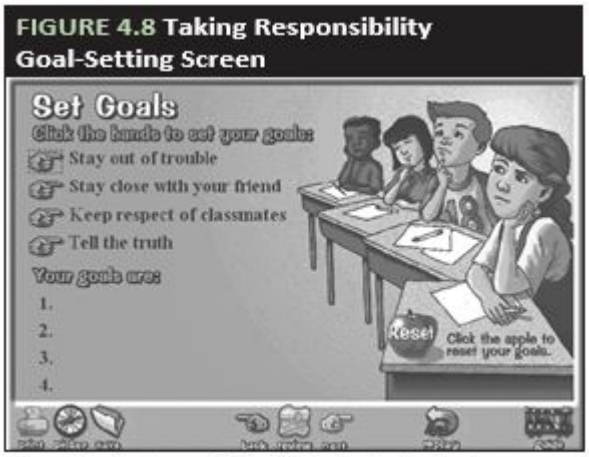



**FIGURE 4.8 Taking Responsibility Goal-Setting Screen**

*Source:* Used with permission of Tom Snyder Productions.

The software comes with many resources to help students think critically about the situations and their decisions and to assist the teacher in integrating literature, role-play, and other activities into the lesson. Each step of the simulation is presented in pictures, audio, and text, which helps ELLs and other students to access the information. The Choices, Choices series includes a number of other titles. Tom Snyder Productions/Scholastic also provides a similar Decisions, Decisions series for older students.

Teachers who want to use this type of software should be aware that the choices that students are allowed to make within the software are preset and represent the views of the software author. Teachers and students must understand the limitations and biases of this software to use it in ways that demonstrate true critical thinking.

### Other Options

There are a variety of other tool options for teachers and students to support critical thinking. Brainstorming and decision-tree software, strengths/weaknesses/opportunities/threats (SWOT) analysis packages, and Web-based content and question tools are available. For more information on teaching critical thinking and how technology might help, see Schwartz (2016) and the TedEd talk “Rethinking Thinking” by Trevor Maber on ed.ted.com.

One recent trend in critical thinking is the development of school- and classroom-based makerspaces. A makerspace is a physical space that contains any array of tools and resources where students can dream, imagine, solve problems, invent, and a lot more. Makerspaces support discovery, creativity, and many of the other goals outlined in this book. For more information, see “7 Things You Should Know about Makerspaces” at https://net.educause.edu/ir/library/pdf/eli7095.pdf and learn more about the maker movement at http://www.makerspaceforeducation.com/.

Additional apps and Web sites can be found in the Teacher Toolbox for this text. Whichever tools teachers decide to use, they need to remember that the tool should not create a barrier to students reaching the goal of effective critical thinking.

## TECHNOLOGY-SUPPORTED LEARNING ACTIVITIES: CRITICAL THINKING

As noted previously, instruction in critical thinking can be direct through the use of explicit instruction or indirect through modeling, describing, and explaining. The goal is to help learners understand clearly why they need to think critically and to give them feedback on how they do and how they can improve. Unfortunately, few software packages and Web sites, let alone textbooks, require critical thinking skills of students. Software that does support critical thinking often requires supplementing to help students understand and use them. Teachers can supplement these resources and facilitate critical thinking during activities by developing external documents. An external document is a kind of worksheet that can involve students in, for example, taking notes, outlining, highlighting, picking out critical information, summarizing, or practicing any of the skills that support critical thinking. An external document can also enhance students' access to critical thinking software or Web sites by providing language or content help. All kinds of external documents exist across the Internet in lesson plan databases, teacher's guides, and other educational sites to be shared and added to.

The goal for an external document is to overcome the weaknesses of the software. An external document should:

Be based on current knowledge in the content area.

Enhance interpersonal interaction.

Provide higher order thinking tasks.

Provide different ways for students to understand and respond.

Enhance the learning that the software facilitates.

Be an integral part of the activity.

Make the information more authentic to students.

Expose students to information in a different form.

Give students more control.

Teachers can use the terms from Figure 4.3 to help plan and create external documents. Like any other

tool, external documents need to be clearly explained and modeled before students use them. To make documents more accessible to students with learning challenges and/or diverse learning styles, teachers can:

Print instructions in a color different from the rest of the text.

Provide oral instructions along with the written document.

Provide visual aids when possible.

Provide slightly different documents for students at different reading or content levels.

Use large, clear print.

In this section, technology-enhanced lessons in critical thinking are supplemented by external documents to demonstrate how teachers can make do with the tools they have and also make the tools more effective. Each example provides an overview of the lesson procedure and the tools used and a sample external document that supports student critical thinking during the lesson. Specific grade levels are not mentioned, because the focus is on the principles behind the activities, and the tasks can be easily adapted for a variety of students. As you read, think about how each external document supports critical thinking and what additional documents might encourage student critical thinking in other ways.

Science Example: Shooting for the Moon

Procedure:

The class reads Space Day—Inventors Wanted at the about.com site (http://childparenting.about.com/). The site gives students guidelines for designing and creating an item for astronauts to take into space.

The class uses a planning tool to decide how to address this task and to make a timeline for completion.

Students make teams and brainstorm their ideas in a word processing or graphics program. They list their re- sources and reasons for using each re- source in the external document, a resource handout (Figure 4.9).

After they make a preliminary decision about their invention, they use the Space Day Invention external document handout (Figure 4.10) to analyze their choices.

Students complete a model of their invention, then use the Invention Justification external document (Figure 4.11) to plan the written explanation that will accompany their model.

**FIGURE 4.10 Space Day Invention Design Requirements**

| Requirement | Results | Meets guidelines? (Yes/no) | Evidence | Changes needed |
|---|---|---|---|---|
| Weight | | | | |
| Capacity | | | | |
| Power | | | | |
| Gravity | | | | |
| Health and Safety | | | | |

**FIGURE 4.9 Space Day Invention Resources**

| | Source 1 | Source 2 | Source 3 |
|---|---|---|---|
| Complete citation | | | |
| Type of source | | | |
| Authors authority | | | |
| Author's purpose | | | |
| Contribution of this resource | | | |

The simple external documents in this case give students a foundation for thinking, a permanent record of their thinking, and assistance for thinking, speaking, and writing about their invention. The range of documents that can be created to facilitate this activity is large; the documents can also be adapted for different students. For example, documents intended for ELLs can include graphics and vocabulary explanations, and those for students with reading barriers can be set up online and read by an electronic text reader. When students finish their project, they can be asked to review their documents to reflect on their thinking processes.

**FIGURE 4.11 Invention Justification Handout**

INVENTION JUSTIFICATION

*Instructions:* Answer the questions below. When you are finished create a summary of your answers that addresses all the questions.

1. In what ways is your invention compact and lightweight? Use examples and information to give evidence that it is. You might compare it to something that we use on earth.

2. What makes your invention easy for astronauts to use? Describe every way that it is easy to use. For examples, you might estimate how long it would take them to learn to use it or how much time and energy it might take.

3. How does your invention improve the astronauts' working or living conditions? Imagine that you are an astronaut being asked to use this item. Describe how it helps you.

Social Studies Example: Election Year Politics Debate

Procedure:

The class reads a variety of Internet sources, popular press, and opinion pieces to gather information to complete the Election Year Issues chart external document in Figure 4.12.

Students choose the issue they decide is most important according to the criteria given and use the Debate Planning document in Figure 4.13 to organize their position.

During the debate, students keep track of and summarize the arguments on a computer screen using a spreadsheet or other relevant software.

After the debate, students try to come to a consensus using all their documentation for support. The Issues chart helps students to focus on crucial aspects of the topic that they are thinking about. This

type of grid can be used for almost any topic area. The debate planning handout is also a multiuse external document that can be employed in debate planning or discussion throughout the year in almost any subject area.

**FIGURE 4.13 Debate Planning Handout**

**Debate Planning**

| Claim | Evidence | Possible counter-claims |
|---|---|---|
| | | |
| | | |

English Example: Critical Reading

Procedure:

After appropriate introduction by the teacher, students in groups of three read one of the three stories about the death of Malcolm X from Dan Kurland's Web site (http://criticalreading.com/malcolm.htm).

Student groups complete the Reading Analysis external document (Figure 4.14), which they would have used previously for other readings.

Student groups reconfigure, with one student from each of the initial three reading groups in a new group (known as jigsaw learning). In their new groups students compare the reports and understandings from their first group and summarize their analysis of all the readings.

**FIGURE 4.12 Election Year Issues Chart**

**Which social problem is the most important?**

| | Number and People Affected | Financial Cost | Other Costs |
|---|---|---|---|
| Racism | | | |
| Pollution | | | |
| Drugs | | | |
| Religion in Schools | | | |
| (write in your issue) | | | |

Students go online to discover other discussions and reports on the death of Malcolm X and to make conclusions about the events and the sources that reported them.

*Instructions:* Read the selection carefully. With your *g*roup, write answers to the questions. Use examples from the readin*g* and other evidence to support your answers.

1. Choose the purpose of this selection from these three choices*:*

    1. To relate facts
    2. To persuade with appeal to reason or emotions
    3. To entertain (to affect people's emotions)

2. Explain why you think this is the purpose. Use examples from the selection to support your idea.
3. Why did the author write this selection?
4. Where and by whom was it published?
5. List all the main ideas in this selection.
6. List any words that you do not know, and add a definition in your own words.
7. Write a short summary of the selection. Limit your summary to five sentences.
8. Decide if the information in this selection is well written. What makes you think so?
9. What are the selection's stren*g*ths and weaknesses?
10. What is your *g*roup's opinion about this selection? Does it seem fair, lo*g*ical, true, effective, somethin*g* else? Explain clearly why you think so and *g*ive evidence to support your ideas.

**FIGURE 4.14 Reading Analysis WWorksheet**

Reading is not only covered in English or language arts areas. Teachers in all subject areas need to help students evaluate sources and become more media literate, and external documents that help them to do so can be used across the curriculum.

Math Example: Write to Dr. Math

Procedure:

Throughout the semester, students choose a math problem that is giving them trouble. They complete the Dr. Math Questions worksheet (Figure 4.15) about that problem. The teacher helps students post their questions to the Write to Dr. Math Web site (http://mathforum.org/dr.math/).

Students use the answer from the experts to analyze their approach to the problem and to answer a similar problem.

**FIGURE 4.15 Dr. Math Questions**

**Write to Dr. Math**

*Instructions:* Answer all of these questions as completely as possible to prepare to ask Dr. Math your question.

1. What is your question about?
   (Please be as specific as you can. Writing something too general, like *math* or *word problem* or *I need help* makes it likely that your question will be ignored.)

2. Write your question, with one specific example.

3. Tell us what you find most difficult or confusing about it.

4. Show us your work or thoughts on this question.



Presenting a problem and their thought processes to an external audience helps students clarify, detail, and explain—supporting the development of critical thinking.

Art Example: Pictures in the Media

Procedure:

Students look at the use of art in advertisements on the Web. Students choose an advertisement about a familiar product.

Examining the art that accompanies the ad, students complete the Advertising Art document (Figure

4.16).

Students choose or create new art for the advertisement based on their answers.

External documents help make the technology resources more useful, more focused, and more thought-provoking. The combination of technology tools and external documents can lead to many opportunities for critical thinking

*Instructions:* Look at the art in your advertisement. Carefully consider your answers to these questions.

Answer as completely as possible.

1. Describe the art objectively, including color selection, line direction, use of shadow and light, and other features. In other words, try not to use any opinion in your description.

2. In words, what do you think this picture is saying? Why do you think so? Give evidence and

examples as support.

3. Is it an accurate representation of the product? How is it related to the product? Explain your

answers clearly.

4. How do you think someone else would respond to the art in this ad? Think of several different

people you know and project what effect the art might have on them.

5. What is the purpose of this art? What do the publishers of this ad hope to accomplish? Why do

you think so?

6. What are the consequences of not knowing the influences that art can have on people?

**FIGURE 4.16 Advertising Art**

ASSESSING CRITICAL THINKING WITH AND THROUGH TECHNOLOGY

Evaluating student work on external documents like those described in the previous section is one way to evaluate student progress in critical thinking. Student use of strategy and other critical thinking software tools can also aid in assessment. Many of the assessment means and tools mentioned throughout this text can assist teachers in evaluating the process and outcomes of student critical thinking. Ennis (2011b) provides several purposes for assessing critical thinking:

Diagnosing students' level of critical thinking

Giving students feedback about their skills

Motivating students to improve their skills

Informing teachers about the success of their instruction.

Although critical thinking tests do exist, Ennis recommends that teachers make their own tests because the teacher-made tests will be a better fit for students and can be more open-ended (and thereby more comprehensive). He makes a logical argument that the use of multiple-choice tests that ask students for a brief written defense of their answers might be effective and efficient.

*Which is more believable? Circle one:*

1. The sewer worker investigates the alligators and says, “I’ve never seen one, so they don’t exist.”
2. The mayor says, “Of course there are no alligators. I would know if there were.”
3. A and B are equally believable.

*EXPLAIN YOUR REASON:*

In addition, both content and thinking skills can be tested simultaneously. For example, the question below requires students not only to answer the question but to explain their logic.

This format gives students who have credible interpretations for their answers credit for answering based on evidence. It can also eliminate some of the cultural and language differences that might otherwise interfere with a good assessment. For example, although the student might mark the multiple-choice part of the question incorrectly due to language misunderstandings or a slip of the hand, the teacher will be able to tell from the written explanation whether the student understands the question and is able to use thinking skills to think through and defend the answer. Students can complete this kind of test on the computer, avoiding problems with handwriting legibility.

Technology can aid teachers in developing tests of this sort. Test-making software abounds both from commercial publishers and nonprofit Web sites; however, few of the multiple-choice test creators also allow for short answers. An effective choice is to use a word processor to develop the test. The test can then be easily revised for future administrations. Teachers who have technical support and/or are proficient in Web page creation can also use an html editor to create a Web-based test.

Measuring critical thinking skills is not easy, but observation over time, a criterion-referenced task, and/or talk-alouds by students during activities are some ways to do so. Self-assessments can also encourage student reflection on how well they have done. Teachers can use a personal digital assistant (PDA) such as a cell phone or iPad to quickly note and store observations and, if necessary, later transfer the notes into a desktop computer for editing and sharing. Most important is to assess many

situations using different methods to get the best idea of which critical-thinking skills students understand and to what degree they use them.

## FROM THE CLASSROOM

### Thinking Skills

There are many activities young children need to be involved in before learning the ins and outs of working a computer. A good book on this topic is Failure to Connect: How Computers Affect Our Children's Minds and What We Can Do About It, by Jane M. Healy. All that said, computers can be extremely motivating and engaging. They can enhance our students' use of collaborative skills and problem-solving skills. These things are very powerful in helping people learn. So while the activities you are thinking of using don't directly match up to whatever test your students need to take, there are many computer activities that will involve many higher level thinking skills that will help our students learn, not only for THE TEST, but for life in general. (Susan, fifth-grade teacher)

### Media Literacy

Learning to recognize bias in any form of media is important, especially on the Internet where anyone can publish. When are students developmentally ready to recognize bias? This is a tough question and will vary for individual students. I think that [the] use of preselected Web sites for fifth and sixth graders is a logical step. This is a good age to point out why you, as the teacher, have selected certain sites for their validity and reliability. This can be contrasted with sites that don't meet the criteria. (Sally, fifth- and sixth-grade teacher)

### Critical Thinking and Word Processing

[An article I read said that] one computer tool [that encourages students to think critically] is the word processor, because as students type, typographical, grammar or misspelled words are highlighted. Students should try to correct it themselves before looking at the suggestions by the computer. . . . this helps students become aware of their mistakes and make a conscious effort to avoid them in the future . . . I think that a conscious effort to avoid mistakes is probably going to take more than just seeing it highlighted as wrong on the computer. I think that some direct instruction or work related to those mistakes might be necessary to really help students critically think about what they did and why it wasn't right . . . because in my experience, the computer's tips aren't always all that helpful. Sometimes I even wonder if spell check helps me to be a critical thinker or a carefree writer who is reliant on the computer to make corrections for me. I'm certainly not dedicated enough to try and correct my mistakes before doing a spelling and grammar check. Can we expect our students to do this? (Jennie, first-grade teacher)

Critical Thinking and the Internet

I appreciate the fact that using the Internet can promote critical thinking because the

students move from being passive learners to participants and collaborators in the creation of knowledge and meaning (Berge & Collins, 1995). The technology is empowering for students. . . They seem to feel more control over what they are able to learn and this seems to be motivating!

I wish I could figure out how to transfer that feeling to activities that are not suited for technology! (April, sixth-grade teacher)

CHAPTER REVIEW

Key Points

Define critical thinking.

There are many different lists of the specific components of critical thinking, but in general experts agree that critical thinking is the process of providing clear, effective support for decisions.

Understand the role of critical thinking in meeting other learning goals such as creativity and production.

Teachers cannot teach their students all the content that they will use in their lives. They can, however, help them to become aware of and develop tools to deal with the decisions they will have to make in school and after. Learning to think critically will help students to become better communicators, problem solvers, producers, and creators and to use information wisely.

Discuss guidelines for using technology to encourage student critical thinking. Techniques such as asking the right questions, using tasks with appropriate challenges, teaching thinking strategies, and encouraging curiosity facilitate more than critical thinking; they are good pedagogy across subjects and activities. Teachers do not need to search for tools to support critical thinking. There are plenty of free tools on the Web, and critical thinking can be supported by common tools such as word processors.

Analyze technologies that can be used to support critical thinking.

People do not often think of a word processor or spreadsheet as a critical-thinking tool, but when their use is focused on aspects of thinking, they can certainly support the process. Many electronic tools can be used to support critical thinking, but teachers must ensure that the tools do not create a barrier to students reaching the goal of effective critical thinking.

Create effective technology-enhanced tasks to support critical thinking.

Any task can have a critical thinking component if it is built into the task. Understanding how to promote critical thinking and doing so with external documents can turn ordinary technology-enhanced tasks into extraordinary student successes.

Employ technology to assess student critical thinking.

Multiple-choice tests in which students are asked to explain their reasons for their answers seem to be a logical and effective way to test not only content but thinking processes. How- ever, this is only one way to assess critical thinking. Teachers need to employ observation, student self-reflection, and other assessments over time to gain a clear understanding of what students can do and how they can improve. Technology can help teachers prepare for and perform assessments

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7

# Chapter 5 Supporting Student Creativity

It is curious how often people assume that creativity is relegated to subjects such as art and drama and overlook its importance in areas such as science, math, and social studies. People often ignore the fact that creative thinkers have established essential breakthroughs in knowledge in all areas—although their ideas may have been considered crazy at first. Of course, K–12 students are not expected to discover a new virus or found a new school of art, but they should be able to think creatively and to understand why it is important to do so. Naturally, the standards for the fine arts mention creativity very clearly and often. In English students are also expected to create texts of different kinds. But how can math be creative? As explained in this chapter, creativity can be characterized as involving the ability to think

Flexibly, or able to use many points of view

Fluently, or able to generate many ideas

Originally, or able to generate new ideas

Elaboratively, or able to add details (Guilford, 1986; Torrance, 1974)

These abilities come into play in many ways in the subject areas. In math, for example, students are expected to work flexibly with different types of numbers to solve problems, and even PE/Health standards require that physical education support student self- expression. In this age of high-stakes testing, creativity is often seen as a curricular “extra,” but there are many compelling reasons, noted throughout this chapter, why it should be central. Clearly, thinking creatively is an important goal for teachers and students.

## OVERVIEW OF CREATIVITY AND TECHNOLOGY IN K–12 CLASSROOMS

Employing a learning focus to support creativity means that before decisions are made about technology use, the whys and hows of creativity are understood.

## What Is Creativity?

There are many definitions of creativity. Which one is relevant depends on whether you are looking at the process, the outcome, or the goal, and which cultural and philosophic views you are taking. Generally, creativity can be defined as the creation of original ideas, processes, experiences, or objects. For example, inventions such as the computer and the printing press and paintings such as the Mona Lisa are creative endeavors. Creativity can also be described as the ability to see ordinary things differently. An often-cited example of this kind of creative thinking is the creation of Velcro, which arose from the observation of cockleburs clinging to clothes. The inventor, George deMestral, clearly was able to see a common item in a different and original way and was able to generate a clear, detailed idea that resulted in his million-dollar product. The developers of the iPod, the cell phone, and the YouTube Web site all employed creative thinking in the creation of their products.

Creativity, or creative thinking differs from critical thinking (chapter 4) in that critical thinking involves the evaluation of whatever is created through the creative thinking process. In real life it is often difficult to separate creative thinking from critical thinking because they are closely related. For example, Rusbult (n.d.) suggests that putting a creative idea into practice without first evaluating it (i.e., thinking critically about it) could result in new problems, and therefore these two processes must go hand in hand. However, it is clear that critical and creative thinking should not happen at the exact same time for most people because criticism can create a barrier to creativity.

Research on creativity goes back a long way—the first formal study was conducted in 1869—and creativity was a topic of discussion and interest long before. In different cultures and disciplines creativity is described and investigated somewhat differently. However, many of the same findings hold true. Paul Torrance, considered a pioneer in creativity research, in his seminal book on creativity (published in 1962) noted as most important that stifling creativity (as many school curricula do) is dangerous both to the mental health and the educational and vocational achievement of children. Other researchers have found that teachers do tend to stifle creativity and focus more on solving close-ended problems that have only one correct answer. However, researchers believe that when teacher involvement in creativity is high (e.g., when they encourage students to see themselves as creative), the creative achievement of students will also be greater (Shepard & Runco, 2016). Research also shows that when appropriate creativity-enhancing processes are valued and supported by a “mentor,” the results are markedly greater. This process can be supported beneficially by technology in ways outlined later in this chapter.

Fasko (2000–2001) reports the following findings in his review of the creativity research that teachers might consider:

Some students are assimilators, or those who prefer to use known understandings to solve problems, and others are explorers, who like to find new solutions. A match between cognitive type and task leads to good problem solving. The variety of resources that the Internet provides can help teachers to create different types of tasks for different types of learners.

Students find tasks more meaningful and so are more motivated when they choose their own tasks. This also applies to the products or outcomes of the tasks. For example, the teacher can provide a variety of WebQuests on the same topic from the WebQuest matrix at webquest.org and allow students to choose their specific topic, task, and creative outcome.

A focus on problem finding, or being able to discern what a real problem is, is as important as one on creative problem-solving. Technology can support problem finding in many ways, including by being used as a resource for world news and views, as an instrument to record survey information, or as a communication tool for brainstorming about problems.

Research also shows that creativity skills do not always transfer from one subject to another. This is because creativity can take on different looks in different subject areas, depending on the goals and values of that discipline. Therefore, creative thinking needs to be taught across disciplinary genres. In other words, creativity is not just a set of technical skills, but rather involves feelings, beliefs, knowledge, motivations, and disciplinary understanding. In addition, a creative idea can arrive in a "Eureka!" moment or be developed over time. It can be completely innovative, or it can be an incremental, original change to something that exists.

Although most creativity researchers believe that all humans have natural creative abilities, they also note that these abilities are rarely fully developed. This could be, as Plsek (1997) noted, because people have certain patterns in their minds that help them to recognize how certain problems can be solved. For example, if a person knows that electric devices do not work unless they are plugged in, when confronted with a device that is not working the person will probably first check whether the device is, in fact, plugged in. This use of previous knowledge will work until the person confronts a situation in which plugging in the device, or seeing that the device is already plugged in but does not work, does not lead to the desired outcome. Plsek suggests that people must break free from the habits of mind that are stored in memory in order to establish new (creative) patterns Teaching creativity can help this to happen.

Characteristics of effective creativity tasks

Figure 5.1 presents characteristics of an effective creativity task. There is no specific checklist for what a creativity task should contain. More important is what the task does. It should:

Focus on content. Although creative thinking can be taught and supported through lesson content or as lesson content, effective creative tasks are based on students' understanding of subject-area concepts. Like critical thinking and problem solving, creative thinking cannot occur without some content knowledge (Baer, 2016; Csikszentmihalyi, 1996). Therefore, a clear focus on content is the most important characteristic of effective tasks. Technology can support content learning in ways described in chapter 2, including supporting endless practice and helping students to connect ideas.

Emphasize divergent thinking. The task should encourage thinking that is out of the norm and goes in many different ways, rather than the typical convergent thinking, which emphasizes working quickly to get to the right answer and is typically used for information learning. In other words, tasks that encourage creativity are open-ended and have many possible solutions or outcomes. Four features of creativity, are often used to teach and measure divergent thinking: flexibility, fluency, originality, and elaboration. Some teachers want their students to converge and do not support divergent thinking. The result could be that students would be careful not to diverge in the future.

Incorporate creativity strategies. Although first published in 1953, the book Applied Imagination, by Alex Osborn (1963), is still one of the most useful books for understanding what creativity is, why it is important, and how it can be nurtured. Osborn's list of more than 70 strategies to promote creative (divergent) thinking has been simplified throughout the creativity literature into eight categories. Tasks that ask students to be creative can include one or more of these strategies:

Combine. Blend two things that do not usually go together.

Try different sequences or layouts. Change parts with other things. Sort it differently.

Adapt. Look at other ways this can be used.

Reverse. Turn it upside down, inside out, front-side back. Change black to white and white to black. Choose the opposite.

Substitute. Find something else that could be a part of this or could do what this does.

Modify. Change the meaning, purpose, color, movement, sound, smell, form, or shape.

Magnify. Enlarge the size, the duration, the frequency; make smaller pieces into bigger segments.

Minimize. Decrease the size or strength; break it down into smaller pieces.

These strategies can be used individually or with each other; they form the basis of the creative thinking techniques mentioned later in this chapter.

Engage students. Student engagement is also essential for tasks in which students are expected to think creatively. Typically, teachers can facilitate student engagement by using authentic content that students understand applies to their lives. The Internet is full of authentic content posted by and for students of the same age and with similar interests as yours.

Employ informational rather than controlling feedback. Informational feedback helps students to understand how their audience understands their work and what the strengths and weaknesses of their work are so that they can continue to assess themselves. Controlling feedback, which evaluates only how well students did compared to other students or to their previous work, can be threatening and disengaging for students (Hattie & Timperley, 2007).

Student benefits from creativity

Students who can think creatively can determine alternatives, solve problems (see chapter 6 for more information on problem-solving), and avoid being what Lutus (2005) calls “lifelong idea consumers” who must consult others rather than working out problems themselves. Creative thinkers can also learn to make “original contributions to the store of human knowledge” (Lutus, 2005, p. 2) and can propose innovations that change their world. Creative students also tend to stay on task longer and therefore achieve more. In addition, creative thinkers can participate in mature risk taking, be flexible and adaptable, and read with greater engagement. Most important, students who can think creatively can have richer and more fulfilled lives.

## THE CREATIVE THINKING PROCESS

Although the creativity literature focuses more on creative thinking strategies than on a specific process, there is some general agreement on the processes that help students become better creative thinkers. Keller-Mathers and Murdock (2002) suggest the following three-stage process for teachers to use in presenting lessons, based on Torrance’s (1962) and other approaches:

Stage 1: Warm up. The purpose is to help students get excited about the activity, access prior knowledge, and understand what to expect. This stage is based on what students already know so that they can generate ideas rather than search for knowledge upon which to base ideas. This is particularly important for ELLs and other students who will be better prepared with the appropriate vocabulary and expectations when these connections are made.

Stage 2: Deepen expectations. During this stage, teachers lead students to become more aware of the challenge that they are facing and apply skills and strategies to deal with the challenge.

Stage 3: Extend the learning. Teachers help students to connect information to their lives, to experiment, and to diverge.

During the three lesson stages, students might employ some variation of the following steps, adapted from Plsek (1997):

Clarify the focus, concept, or problem that requires new ways of thinking.

Review the facts. Student prior knowledge is activated as they lay out the problem or idea in detail.

Identify elements that could be modified. Content knowledge is called on as students apply new ideas to old.

Restate the focus by suggesting modifications. Osborn's strategies (listed previously) are useful here, as are creativity techniques that fit the context.

Develop the idea further to meet practical constraints; this requires critical thinking skills.

Test it. Say it, create it, try it, and look at the results.

Black (1990a) provided a fun example using the idea that 1 + 1 does not always equal 2. He shows how, through the creative thinking process, students can come to understand that two insects of different genders, left alone, may come to equal many more than two; one dollop of blue paint added to one dollop of yellow will equal a new color entirely; one person's ideas added to another person's ideas can equal many new ideas; and one computer and one person together can equal all kinds of things. This example also demonstrates clear divergent thinking. Keller-Mathers and Murdock (2002) provide useful lessons that apply the stages of the creative thinking process. One of these lessons is reproduced in Figure 5.1.

FIGURE 5.1 Creative Thinking Process Lesson Example

Look At It Another Way Lesson
Content AND Creativity Objective
to identify and practice the key characteristics of Look At It Another Way by examining different perspectives to promote incubation through the deliberate use of three stages and strategies.

Materials: kaleidoscopes, multiple examples of half of eight, pictures that can be viewed in more than one way (e.g., two faces/vase, old woman/young woman).

Warming Up
To get attention and heighten anticipation, have the room arranged in a different way before students come in (e.g., reverse back to front). To arouse curiosity about what is going to happen, have small kaleidoscopes out on every desk.
To provide focus and motivation, use the kaleidoscopes to encourage playfulness, and then begin a discussion about the characteristics and results of looking at things differently. Have students view the room through a kaleidoscope and describe what they see. Ask them How do things look different? What do you notice that you didn't see before? Discuss how familiar things begin to look different through the kaleidoscope.
Continue the warming up practice by showing a picture that can be viewed in more than one way (for example, the old woman/young woman perception drawing). Ask students: What do you see? What else do you see? Who sees something different? How were you able to switch from one view to another? Was it easy or hard?

Deepening Expectations
To make the transition into deepening expectations while sustaining motivation, begin a discussion on the various responses that are common when asked What is half of eight? Then ask students to dig deeper into this question and consider answers that require a different perspective. If you were playing a game of pool, for example, half of eight might represent half of the number eight ball. If you considered fractions, you might answer 4/8th. If you examined the question from the perspectives of the months of the year, the answer might be April. Have students draw, write, or state many perspectives to answer this question. Encourage surprising angles and uncommon views. Discuss how in viewing this differently you've taken something that's familiar (half of eight is four) and made it strange by considering the various ways one might answer this question.

Extending the Learning
To facilitate incubation and continued thinking, encourage students to keep their kaleidoscopes with them for the rest of the day and to take them out at least three times to look around and remind themselves to look at things differently. Ask students to stop and consider a different perspective to situations or concerns that arise throughout the day. Continue students' thinking through a journaling activity where they observe, discuss, or reflect on looking at things differently by "making the strange familiar and making the familiar strange."

## Teachers and Creativity

### The teacher's role

Teachers may inadvertently stifle creativity in the push to complete the assigned curriculum, but there is no reason why creativity cannot be an integral part of the curriculum. As with the other instructional goals and strategies described in this text, to truly support student creativity the teacher should structure activities according to curricular goals, standards, and students' knowledge and needs, and then provide relevant support as students work toward their own understandings.

In structuring creative activities, teachers can follow some general guidelines that apply to developing technology-supported critical and creative capacities in students of all ages. These include:

Choose real objects and experiences over workbooks and textbooks in developing under- standing

whenever possible. For example, instead of a drawing of the inside of a frog, use a Web site that shows actual dissection photos, such as NetFrog (http://frog.edschool.virginia.edu//) or the Virtual Lab at http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html. Or, rather than using templates, used open-ended software such as a word processor for presentations, brochures, cards, and other products.

Consistently allow for students' input into establishing the criteria for the evaluation of classroom activities, assignments, and behaviors. Let students describe the ways in which they should be evaluated, whether by computer-based test or multimedia-supported presentation.

Choose to display students' work over commercially prepared displays. Allow students to decorate the classroom with important concepts and information presented in creative ways through the use of computer technologies.

Consistently offer and encourage students to seek alternative ways of responding to structured art activities, fulfilling learning requirements, or completing a craft, project, or assignment. Make all kinds of technologies available so that students have choices in their responses. (Adapted from Saskatchewan Education, n.d., n.p.)

Creativity tasks are great for avoiding plagiarism (described in chapter 6) because individual responses are expected to be original and there is not one "right" way to complete such a task.

In addition, teachers need to ask good questions, as they do to reach many instructional goals. For creative thinking, teachers need to ask students questions that encourage them to be flexible, to think of more ideas, to expand on their ideas, and to think "out of the box."

Another role for teachers is to model creative thinking. To do so, teachers should:

Be open-minded, encouraging students to follow their own thinking and not simply repeat what the teacher has said.

Change their own position when the evidence warrants, being willing to admit a mistake.

Consistently provide opportunities for students to select activities and assignments from a range of appropriate choices.

Exhibit genuine interest, curiosity, and commitment to learning.

Undertake the organization and preparation required to achieve learning goals.

Seek imaginative, appropriate, and ethical solutions to problems.

Be sensitive to others' feelings, level of knowledge, and degree of sophistication.

Show sensitivity to the physical elements that contribute to a stimulating learning environment through the physical arrangements and displays they provide or facilitate.

Allow for student participation in rule setting and decision making related to all aspects of learning, including assessment and evaluation. (Saskatchewan Education, n.d., p. 5)

Most important is that teachers learn how to teach playfully, which means working on creativity tasks right along with the students, suggesting “crazy” ideas, taking risks, using humor, and modeling their own creative thinking process. This helps all students to understand both the process and the outcomes of creativity.

### Challenges for Teachers in Creating Technology-Supported Opportunities for Creativity

Teachers can be challenged by any part of the creative thinking process, whether in developing their own abilities or working with students. However, two central barriers exist. First, school is often a place where creativity is not supported, having an individual thought is not encouraged by peers, and conformity is expected. It would be difficult to teach in a classroom without any rules or norms, but there can be different ways to conform that also allow creativity to flourish. The challenge for teachers is to find these ways.

A second challenge, mentioned at the end of the previous section, is for teachers to model creativity. This includes learning and using strategies and techniques, developing and using tasks that call for creative thinking, and exhibiting enjoyment and achievement in creativity. All teachers are creative in some ways; teachers need to discover these ways and build on them. The guidelines in the next section of this chapter provide some basic suggestions for how teachers might address both challenges.

## GUIDELINES FOR SUPPORTING STUDENT CREATIVITY WITH TECHNOLOGY

The description of the teacher’s role, task characteristics, and benefits of creative thinking presented in this chapter help teachers to understand the basics of creativity in classrooms. The following guidelines, while more practical, also present more in-depth information.

### Designing Creativity Opportunities

Many classrooms are physically sterile, with commercially made visuals posted just so, rows of desks that do not move, and everything in its “correct” place. Such classrooms are often also psychologically sterile, with rules about cleanliness, orderliness, and what must get done rather than what can be done. According to Black (1990b) and to those who study brain-based learning (e.g.,NEA, 2014), positive

psychological factors in the environment are some of the most important elements in encouraging creativity. Black notes that people need their environments to be fun, honest, caring, sincere, flexible, supportive, encouraging, challenging, growth-oriented, free of politics, focused on learning, open to nonsuccess, free of manipulation, and free of "backstabbing" (1990b, p. 2). Other researchers agree, noting that learners need to be in an environment where they feel free to take risks; have opportunities to play with materials, information, and ideas; and have the time and feedback they need, whether individually or in groups. The following guidelines suggest ways to deal with these issues.

Guideline #1: Create an enriched environment.

Features of the environment that can smother creativity include rewards, time pressures, over-monitoring, competition, restricted choice, and high-stakes evaluation. Environments that support creativity are those that create alternatives to these features and allow students to explore, cooperate, and pace themselves. An environment that supports creativity is also one that is rich with examples and opportunities; technology is particularly useful for providing a wide range of resources and choices. Moving desks around, taking a playful attitude, having students share their work with local and online peers, providing both quiet and group areas, and posting new ideas are some ways to enrich both the physical and psychological spaces in the classroom.

In addition, a creative environment must "feed the senses" by including visual, aural, kinesthetic, and other stimulation. Students can decorate, bring in something that smells different, play a variety of music, and use different group and physical arrangements to incite creativity. An environment that supports creativity in these ways also allows students with diverse abilities, language and cultural backgrounds, and content and language skills not only to access more easily what is happening in the classroom but perhaps also to participate more in creative tasks.

Guideline #2: Teach techniques.

During the creative thinking process, an amazing number of specific techniques can be taught and used, many of which are based on Osborn's strategies discussed in the process section

**B**

- Backwards Forwards Planning
- Boundary Examination
- Boundary Relaxation
- BrainSketching

- Brainstorming
- Brainwriting
- Browsing
- Brutethink
- Bug Listing
- BulletProofing
- Bunches of Bananas

**FIGURE 5.2 Creativity Techniques Starting with "B" from mycoted.com**

of this chapter. More than 200 techniques are described at www.mycoted.com/creativity/techniques/index.php (Mycoted, n.d).

Figure 5.2 presents just the "B" portion of the creativity techniques from mycoted.com. Most teachers will be familiar with brainstorming and browsing, but may be surprised to read about all of the other possible ways to teach creative thinking techniques. For example, "bug listing" is described as:

simply a list of things that bug you! It should be personal and illuminate specific areas of need. Adams recommends keeping it fluent and flexible, remembering humorous and far-out bugs as well as common ones. He suggests that if you run out of bugs in under ten minutes, you are either suffering from a perceptual or emotional block or have life unusually under control! It may well be the most specific thinking you have ever done about precisely what small details in life bother you; if properly done, your bug list should spark ideas in your mind for inventions, ideas, possible changes, etc. (http://www.mycoted.com/Bug_Listing)

If students feel comfortable sharing, they could word-process and share their lists with peers, possibly sparking ideas in their minds, too.

Brainstorming is without doubt the most important technique for encouraging creative thinking, but it has to be done correctly in order to maximize its benefits. Rules for classic brain- storming include:

Do not criticize any ideas during the brainstorming process. There will be time for this later.

Generate as many ideas as possible. Do not worry whether they are practical or possible at this point.

Do not stop to discuss the ideas—keep generating them for as long as possible.

Try to piggyback on other ideas, generating still more ideas. Do not worry if they are only incrementally different.

Since Osborn proposed it in 1963, research has shown repeatedly that the more ideas a person generates, the better the chance that one of them will be new and useful.

Fogler and LeBlanc (2005) provide a funny and useful list that shows the results of brain- storming. Some of their "suggested uses of old cars as equipment for a children's playground" include:

Get on the roof and use the car as a slide.

Take the seats out and use them as a bed to rest between activities.

Teenagers could take the engine apart and try to put it back together.

Make a garden by planting flowers inside.

Use the tires to crawl through as an obstacle course.

Take off the doors and use as a goal for hockey. (n.p)

Guideline #3: Let students show what they can do, rather than what they cannot.

The high-stakes testing that is prevalent nationwide lets teachers know what their students cannot do; standardized tests cannot easily do more. Although tests can provide teachers with important information, they do not provide a whole picture of students' abilities. Allowing students to produce creatively builds on student successes and helps students to understand that they can think differently and still "pass." This idea is discussed further in the assessment section later in this chapter.

Guideline #4: Teach respect for ideas and people.

When students fear criticism or are worried about competition, they may find it difficult to take risks and to be creative. This does not mean that classroom activities always have to be cooperative or that students should be taught to always agree with others, but teachers and their students can reflect on the reasons for treating people and ideas with respect and how this can be done. Working on respect also supports the team-building skills mentioned in other chapters in this book.

## CREATIVITY TOOLS

Criticism can have a negative effect on creativity. Do computer tools also suppress creativity? Lutus (2005) suggests that they may when the user is "reduced to following a single behavioral pattern built into the program by its designers" (p. 3). Microsoft PowerPoint, in particular, has been criticized fairly often for allowing users to apply only pre-specified formats (however, there are also benefits of using this software).

Some educators suggest that computers are taking away creativity in music and art, just as calculators might de-skill students in math, because they take away opportunities for students to work with other tools. However, creative learners and teachers can use these tools in ways that support and inspire

creativity if they understand the options that the tools afford. That tools might work against creativity—for example, by providing preset formats and inserts that students cannot change or limiting what can be included on a page—means that teachers must ensure that the tools used enable students to do what they need to and want to do. It also calls attention to the idea that students need to develop skills and then use technology, not use technology as a replacement or shortcut. Cameron (2000) explains,

in those fields where creativity is to be fostered, we must teach students that the ideas and content of their work must precede and supercede the implementation of the work. Technology helps them implement. Only their own creativity and thoughts can make their work original and worthwhile. (p. 6)

There are electronic tools that can support different strategies and parts of the creativity process. For example, videos that stretch the boundaries of what can happen can provide fodder for imagination. In addition, communication tools such as those described in chapter 3 allow students to exchange ideas and build on each other's creativity. Productivity tools (chapter 7) allow learners to put their ideas into practice and explain them to others. Critical thinking tools (chapter 4) help students to evaluate their creative process and products. Most important for the use of technology to support creativity is that teachers and students choose the one(s) that best help them express themselves. However, teachers who are daunted by the range of tools that can support creative thinking can invest in learning about one or two tools (for example, Inspiration and a good word processor) that can facilitate a large range of ideas and products.

Of course, as Cameron notes, being creative does not require electronic technologies. However, if technology can stir creative ideas, support their expression, facilitate and/or pro- vide opportunities for creativity, and encourage the use of strategies and techniques, it can benefit the creative thinking process. The following creativity tools can be used effectively during one or more parts of the creative process. They are listed by type of tool and include a brief description of what it does followed by some possible classroom uses and specific examples.

Puzzles/Puzzle makers

Description and uses

There are many kinds of puzzles, from jigsaws to math equations, and most require creative thinking to put together or solve. Jigsaw puzzles with content arranged in specific ways can be used as a fun warm-up activity or as a visual to assess student understanding. Puzzles are useful to promote interaction during group work, and creativity is definitely required to develop puzzles for others.

Examples:

Creative Java Puzzles, http://www.enchantedmind.com/

Jigsaws at http://www.shockwave.com/

Jigsaw maker or bigjig, http://www.lenagames.com/bigjig.htm

Primary Power Pack (Puzzle Power, Jigsaw Power) from Centron Software

There are also many crossword puzzle makers that encourage students to work creatively with language.

Authoring Environments

Description and uses

These tools allow users to design and create software, Web sites, documents, and other products such as book reports and projects that include sound, graphics, animation, and video. A wide variety of classroom uses is possible, from designing a classroom Web site for parents to access to developing a system for interacting with peers around the world.

Examples:

PowerPoint (www.microsoft.com) or other presentation software (e.g., Powtoon, Prezi)

Free web sites at wix.com or weebly.com

Code.org and other sites that provide support for coding

There are many more tools for course, Web, multimedia, and MOO development, some of which are aimed at K–12 classrooms, and some of which require more technical skills. However, they all require creativity and allow users to determine the look and feel of their electronic environment.

Video Editing Software

Description and uses

Video editing software can allow students the freedom to create amazing products. For example, students can create their own brief videos from photos or graphics, interpret a story or poem that they have written, or edit a performance.

Examples:

iMovie, bundled with the Mac operating system and also available through http://www.apple.com

MovieMaker, bundled with some of the Microsoft operating systems and available free elsewhere on the Web, www.microsoft.com

Adobe Premier Elements, http://www.adobe.com

Software is available for novice users who want to make videos for MP4 players or to post to Web logs (blogs).

Thought Exercises

Description and uses

Thought exercises are problems from any field that usually require minimal content knowledge. They can be used to show transfer of creative thinking from one domain to another, as warm-up exercises, as free-time tasks, or to apply newly learned creative thinking techniques. Students could also use them as models to build their own exercises.

Examples:

Robert Black's creativity challenges, www.cre8ng.com/CC/index.shtml

Creative & critical Thinking Activities for the Middle or High School Classroom from teachers.net Gazette: https://www.teachers.net/gazette/FEB08/critical_thinking_activities/

Collaborative Idea Databases

Description and uses

A creativity pool is a database that gathers innovative ideas. Students can search for an idea under a specific topic or they can contribute their own.

Example: The Creativity Pool, http://www.creativitypool.com/

Idea/Object Generators

Description and uses

A generator, typically, randomly generates an idea or an object in some topic area. Using a generator can help students get an idea going, figure out what questions to ask, get their mind off a problem for a while, or relate to content in some creative way.

Examples:

There is a fairly comprehensive list of generators at http://generatorblog.blogspot.com/, but many of the generators are not appropriate for K–12 classrooms. Some of the more fun or interesting generators that may be used with K–12 students include:

Make-a-Flake (make your own snowflake), http://snowflakes.barkleyus.com/

What animal are you? http://www.2on.com/

The What-if inator by seventh sanctum generates all kinds of interesting and often wacky ideas, at http://www.seventhsanctum.com/generate.php?Genname=whatif

Good Idea Generator software by http://chaoticshiny.com/goodideagen.php (high school and above).

Kids can create and dress the snowman at http://www.abcya.com/snowman.htm in many ways.

Graphics/Concept Mapping

Description and uses

Graphic organizer software is useful for all the goals mentioned in this book. During the creativity process, students can use it to generate and connect ideas, design, plan, and even evaluate.

Examples:

The most popular are Inspiration and Kidspiration (http://www.inspiration.com/); also useful are apps like Popplet and the web site Creatley at https://creately.com/.

Painting/Drawing

Description and uses

Most computers come preloaded with some type of paint program (on your PC, look under Programs—Accessories), and other more powerful programs are available commercially. Still others can be downloaded free from the Web (search, for example, http://www.freedownloads center.com/). Students can use paint software to create original art or to reconfigure photos and other graphics files.

Examples:

Microsoft Paint, bundled with the Microsoft operating system.

Tux Paint (younger kids), a free download from http://www.tuxpaint.org/

Adobe Illustrator/Adobe Photoshop (high school), http://www.adobe.com

Other software packages such as KidPix and Microsoft Word include painting and drawing tools as do most social media apps.

Story Starters/Bookmaking/Publishing Software

Description and uses

These software types allow students to create stories and books, produce pamphlets and posters, and develop cards for all occasions. Although structured in some ways, most of these software packages are content-free. They include audio, choices of graphics, and even a variety of languages, so English language learners can use them effectively, too. Students can create new holidays and cards to go with them, develop an ad campaign for a new invention, or write a book that presents history in a new way.

Examples:

Any word processor

Story Starters by Scholastic makes hilarious combinations of people, places, and things for students to write about at www.scholastic.com/teachers/story-starters/.

Writing Exercises' Random First Line Prompts at http://writingexercises.co.uk/firstlinegenerator.php.

StoryJumper is a very popular site for creating books at www.storyjumper.com

Search on the Internet for any of these types of software and there will be choices for all ages.

Brainstorming Software

Description and uses

There are many brainstorming tools that support user idea generation. Students can use them to generate story starters, gather ideas to solve problems, discover names for the class pet, or any number of other tasks.

Examples:

Kidspiration/Inspiration, versatile software that can be used in many of these categories, http://www.inspiration.com

See the Educational Technology and Mobile Learning site at

http://www.educatorstechnology.com/2014/03/the-best-mind-mapping-tools-and-apps.html for a list of tools.

Check the Teacher Toolbox that supplements this text for more creativity apps and web sites.

Students can use many of these tools merely by clicking, but there are also assistive tools for students who cannot type on a regular keyboard or who need graphics to understand key functions. Overlay keyboards, also known as concept keyboards, are flat input devices connected to a computer. An overlay is laid on the board to show what will happen when parts of the board are pressed (or, for students who cannot press, when they are touched lightly). Overlay keyboards can be used for foreign languages, for simple keyboard layouts, for larger keys, for graphical representations of the input, and for tactile or other assistance for students with visual impairments.

It is how the tool is used, not necessarily what it contains, that makes it a creativity tool. Students can build with Legos or make art with 3D pens as a creativity exercise. Other creativity tools are listed in the learning activities section.

## LEARNING ACTIVITIES: CREATIVITY

Many of the learning activities described in other chapters of this book require students to think in creative ways, but they do not have a specific focus on creativity. For example, the activity in chapter 4 during which students develop an invention combines production, communication, and creativity. However, no specific creative strategies or techniques were mentioned. The activities in this section are examples of different ways to model, practice, and/or use creative thinking during technology-enhanced tasks. Each content area example includes a goal and describes a specific creative thinking strategy or technique (although others may be included) and an appropriate tool. These examples can be modified for a variety of classrooms.

### Math Example: What Would Pythagoras Say?

Goal: To show flexibility in mathematical understanding.

Technique: Analogical thinking. This technique asks students to transfer an idea from one context to another. For example, in learning addition, students might make an analogy such as, “It’s like when you have a cookie and you really, really want two, and since you already have one you need to ask your mom for another one. You are adding one and one to have two cookies.”

Activity and Tool: Students come up with analogies that Pythagoras might have used to explain his theory. They then use Crazy Talk software (from reallusion) to animate Pythagoras’ photo and make him explain the analogy. This activity also can be done in most other content areas.

Vocational/Life Skills Example: Who Will You Be?

Goal: Use humor to understand college and career possibilities and to think about these options in different ways.

Technique: Rearrange/combine. Students use these strategies, described previously in the process section, to come up with innovative college programs.

Activity and Tool: Students use online college catalogs and put together courses that could lead to a degree in a profession not generally taught. For example, a job as a mermaid might require courses in oceanography, physical education (diving), botany, veterinary medicine, and organic nutrition, among others. Students can use tools such as Washington State University's online catalog at http://catalog.wsu.edu/. They can produce pamphlets for their programs using desktop publishing software.

English Example: Everything Old Is New Again

Goal: Conceptualize a modern version of a classic novel.

Technique: Storyboarding. This technique requires students to post their ideas in text or other visuals so that they can clearly reflect on what they have said and add to the ideas.

Activity and Tool: Students study a piece of classic literature and specify its attributes (plot, characters, etc.). They use a variety of strategies while brainstorming to change/adapt the attributes and write a modern version of the story. Students can brainstorm using a text chat program (see chapter 3 for more information on chatting) or a free site like Voicethread (voicethread.com). See the list of interactive whiteboard apps at common sense education (https://www.commonsense.org/education/top-picks/top-interactive-whiteboard-apps) for additional tools.

Social Studies Example: Alternative Pasts

Goal: To understand how events interact and how history is made.

Technique: Assumption dropping. Students list the assumptions associated with the events, and then explore what happens as they delete each of these assumptions individually or in combination. They would ask, for example, what if Paul Revere couldn't ride his horse? What if Japan hadn't bombed Pearl Harbor?

Activity and Tool: Students must come up with a plausible series of past events that would have changed history in some way and then carry forward the historical stream to the present. As they create their alternative history, they document and compare it to the actual events using timeline software (search “timeline software for kids”).

Language Arts Example: Break the Code

Goal: Help students to understand patterns in language.

Technique: Modify. As mentioned previously, students use this strategy to change an item or idea by modifying the meaning, purpose, color, movement, sound, smell, form, or shape.

Activity and Tool: Students type a message using a word processor and then change it to a symbol font and see if others can “break” their code (adapted from James & Kerr, 1997, p. 28).

Music Example: What Is Music?

Goal: Demonstrate understanding of characteristics of musical genres by creating a parody. Technique: Exploratory browsing. Students look through a series or collection of ideas or things looking for inspiration.

Activity and Tool: Students search one of the many online lyric databases (e.g., A-Z Lyrics Universe [azlyrics.com] or SoundTrack Lyrics [stlyrics.com]) to analyze songs from one or more musical genres. They define the attributes of that genre and then create their own parody using a popular song from the chosen genre. Different kinds of song parodies can be found in many places on the Web, including http://www.amiright.com/ and many YouTube channels Students must be aware, however, that parodies are satire, not fact.

Science Example: Home Sweet Home

Goal: Recognize the contributions to physical, social, and cultural environments made by residential buildings and work to enhance beneficial aspects.

Technique: Attribute listing. This technique requires students to identify the key features of something and then think of modifications.

Activity and Tool: Students create an ideal community based on balancing the needs of the environment with residents’ social and cultural needs. They can use any of the many town-building apps available or

the old standard, SimCity (Maxis; http://www.maxis.com) to demonstrate their plans. The SimCity simulation will also provide feedback on whether the plan is viable or not.

Physical Education Example: Let's Pretend

Goal: To invent a new game.

Technique: Random input. Among a list of words, choose one randomly and try to use it.

Activity and Tool: Students write random words on index cards and mix them into a pile. Stu- dents take one (or more) card(s) from the pile and use the word(s) as a basis for developing

a new game. They must lay out the rules in a word processor clearly enough so that other students can actually play the game. Students try it, then the creators revise it and submit it to an online forum for others to try.

There is really no end to the ways that creative thinking can be supported in classrooms and in the ways that technology can support and enhance creativity.

## ASSESSING LEARNER CREATIVITY

More than 200 standardized instruments exist that measure creativity, but most are not useful for everyday assessment. This is because they often need to be evaluated by experts, there is some cost attached, and they can require expertise to administer. However, there are ways for teachers to assess creativity. Most of the literature on assessing creativity suggests three types of assessment: (1) tests of knowledge and skills, (2) performance assessments to evaluate the process, and (3) personal communication and observation to understand both process and product.

First, because content knowledge is essential for creativity, assessing students' knowledge base is crucial for understanding why and how they use creative thinking skills. Content assessments are discussed in chapter 2.

Second, in order to use performance assessments that are authentic tasks, clear assessment criteria are necessary. Guilford (1986) and Torrance (1974) propose as criteria the four aspects of divergent thinking mentioned several times in this chapter:

Fluency (number of ideas)

Flexibility (variety of ideas)

Originality (new or unusual ideas)

Elaboration (adding detail to ideas)

Quantity can also be an elements of creativity assessment since the generation of a lot of ideas is ideal. These aspects of creativity can form the basis of a rating scale. Teachers can, for example, provide a rubric that asks students to generate a certain number of ideas, explain how they came to their ideas, and provide a rationale for their final choices. Students can respond in reflective journals.

Checklists, in which teachers or students check off criteria when they are met, can also help students to move through the process. Students can self-evaluate according to their performance on the checklist items.

Miller (2013) notes that, although teachers may not think so, creativity can be assessed. Teachers can use observation and data records to determine what is creative for each child. Personal communication between students can also be valuable for assessment and for creativity; students who assess another's creative process and product may benefit from looking at the ideas of their peers. Electronic portfolios, discussed in chapter 8, may also be an effective way of assessing creativity because they allow students to store and reflect on a variety of artifacts and show progress and change over time.

However, teachers choose to assess creativity and creative tasks, the assessment needs to take place across disciplines to account for the disciplinary bases of creativity that may not transfer across subject areas.

FROM THE CLASSROOM

Technology and Assessment

I also can see the benefit of using the computer to support assessment, as well as to prepare it. Performing assessment is a bit troublesome for me as well. I think that for certain things, such as the state driver's license exam, the computer tests are probably a lot more efficient because they get so many more people tested in the same amount of time, with little preparation for the people administering the test . . . I do question the ability of the computer to accurately assess or measure, as it can only do what it is programmed to do. Students and kids are way more creative and spontaneous than any software program! Also, we have to ask the question if using the computer to perform the assessment would be an authentic measurement. Was instruction and content similar to the form of the assessment? I'm also concerned that some teachers might use computers to perform assessments without taking into consideration the importance to adapt or accommodate the diverse needs of their students. Perhaps some students are ELLs, or others have a learning disability. How will the computer treat them? (Jennie, first-grade teacher).

The use of the computer as an assessment tool has revealed many limitations so far. But the major benefit of a computer assessment tool might be that it can provide students expanded opportunities to represent their abilities. For example, students can freely express their abilities by using audio/video tools if they are well trained in the use of technology. In addition, once a certain assessment tool is made, it can be semi-permanently used. And the performance information of students can be easily stored. (Keun, teacher educator).

## CHAPTER REVIEW

### Key Points

Define creativity.

This chapter defined creativity as the creation of original ideas, processes, experiences, or objects, or the ability to see ordinary things differently. However, these are relatively simplistic explanations of a complex phenomenon. Researchers are just beginning to understand the biological, social, cultural, and environmental foundations of creativity.

Understand the importance and benefits of creativity to life and learning.

There are both psychological and more practical reasons for students to be creative thinkers. From helping students to find meaning in their learning to meeting standards to making students highly employable, creative thinking skills are in demand in almost every arena. More important, they are needed for quality of life before, during, and outside of school.

Discuss guidelines and technological tools for encouraging student creativity.

Although humans may be biologically predisposed to creativity, most people have not developed their creative potential. Teachers can help their students in this process by creating an enriched environment, direct teaching of creative thinking techniques, letting learners show what they can do, and teaching students respect for ideas and people. Tools that can enhance creative thinking and the development of creative thinking skills range from the word processor to brainstorming programs. Most important is that teachers use tools that are appropriate for what students are expected to do. Teachers also can be creative in the selection of such tools.

Create effective technology-enhanced tasks to support creativity.

Effective creativity tasks consider students' content knowledge, use convergent but emphasize divergent thinking, incorporate creative thinking strategies, engage students in tasks that have meaning for them, and provide informational feedback so that students under- stand their progress.

Assess creativity and technology-enhanced creative tasks.

Creativity and creative tasks should be assessed in at least three ways–through content testing, performance assessment, and personal communication. The format of these assessments can vary, but specific criteria should be used and formative feedback should be one outcome.

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# 8
# Chapter 6 Supporting Student Problem-Solving

Across content areas, the standards address problem-solving in the form of being able to improvise, decide, inquire, and research. In fact, math and science standards are premised almost completely on problem-solving and inquiry. According to the literature, however, problem-solving and inquiry are often overlooked or addressed only superficially in classrooms, and in some subject areas, are not attended to at all.

## OVERVIEW OF PROBLEM-SOLVING AND INQUIRY IN K–12 CLASSROOMS

In keeping with a learning focus, this chapter first discusses problem-solving and inquiry to provide a basis from which teachers can provide support for these goals with technology.

### What Is Problem-solving?

Whereas production is a process that focuses on an end-product, problem-solving is a process that centers on a problem. Students apply critical and creative thinking skills to prior knowledge during the problem-solving process. The end result of problem-solving is typically some kind of decision, in other words, choosing a solution and then evaluating it.

There are two general kinds of problems. Close-ended problems are those with known solutions to which students can apply a process similar to one that they have already used. For example, if a student understands the single-digit process in adding 2 plus 2 to make 4, she most likely will be able to solve a problem that asks her to add 1 plus 1. Open-ended or loosely structured problems, on the other hand, are those with many or unknown solutions rather than one correct answer. These types of problems require the ability to apply a variety of strategies and knowledge to finding a solution. For example, an open-ended problem statement might read:

A politician has just discovered information showing that a statement he made to the public earlier in the week was incorrect. If he corrects himself he will look like a fool, but if he doesn’t and someone finds out the truth, he will be in trouble. What should he do or say about this?

Obviously, there is no simple answer to this question, and there is a lot of information to consider.

Many textbooks, teachers, and tests present or ask only for the results of problem-solving and not the whole process that students must go through in thinking about how to arrive at a viable solution. As a result, according to the literature, most people use their personal understandings to try to solve open-ended problems, but the bias of limited experience makes it hard for people to understand the trade-offs or contradictions that these problems present. To solve such problems, students need to be able to use both problem-solving skills and an effective inquiry process.

## What Is Inquiry?

Inquiry in education is also sometimes called research, investigation, or guided discovery. During inquiry, students ask questions and then search for answers to those questions. In doing so, they come to new understandings in content and language. Although inquiry is an instructional strategy in itself, it is also a central component of problem-solving when students apply their new understandings to the problem at hand. Each question that the problem raises must be addressed by thorough and systematic investigation to arrive at a well-grounded solution. Therefore, the term “problem-solving” can be considered to include inquiry.

For students to understand both the question and ways of looking at the answer(s), resources such as historical accounts, literature, art, and eyewitness experiences must be used. In addition, each resource must be examined in light of what each different type of material contributes to the solution. Critical literacy, or reading beyond the text, then, is a fundamental aspect of inquiry and so of problem-solving. Search for critical literacy resources by using “critical literacy” and your grade level, and be sure to look at the tools provided in this text’s Teacher Toolbox.

## What Is Problem-Based Learning?

Problem-based learning (PBL) is a teaching approach that combines critical thinking, problem- solving skills, and inquiry as students explore real-world problems. It is based on unstructured, complex, and authentic problems that are often presented as part of a project. PBL addresses many of the learning goals presented in this text and across the standards, including communication, creativity, and often production.

Research is being conducted in every area from business to education to see how we solve problems, what guides us, what information we have and use during problem-solving, and how we can become more efficient problem solvers. There are competing theories of how people learn to and do solve problems, and much more research needs to be done. However, we do know several things. First, problem-solving can depend on the context, the participants, and the stakeholders. In addition, studies

show that content appears to be covered better by “traditional” instruction, but students retain better after problem-solving. PBL has been found effective at teaching content and problem-solving, and the use of technology can make those gains even higher (Chauhan, 2017). Research clearly shows that the more parts of a problem there are, the less successful students will be at solving it. However, effective scaffolding can help to support students’ problem-solving and overcomes some of the potential issues with it (Belland, Walker, Kim, & Lefler, 2017).

The PBL literature points out that both content knowledge and problem-solving skills are necessary to arrive at solutions, but individual differences among students affect their success, too. For example, field-independent students in general do better than field-dependent students in tasks. In addition, students from some cultures will not be familiar with this kind of learning, and others may not have the language to work with it. Teachers must consider all of these ideas and challenges in supporting student problem-solving.

Characteristics of effective technology-enhanced problem-based learning tasks

PBL tasks share many of the same characteristics of other tasks in this book, but some are specific to PBL. Generally, PBL tasks:

Involve learners in gaining and organizing knowledge of content. Inspiration and other concept-mapping tools like the app Popplet are useful for this.

Help learners link school activities to life, providing the “why” for doing the activity.

Give students control of their learning.

Have built-in and just-in-time scaffolding to help students. Tutorials are available all over the Web for content, language, and technology help.

Are fun and interesting.

Contain specific objectives for students to meet along the way to a larger goal.

Have guidance for the use of tools, especially computer technologies.

Include communication and collaboration (described in chapter 3).

Emphasize the process and the content.

Are central to the curriculum, not peripheral or time fillers.

Lead to additional content learning.

Have a measurable, although not necessarily correct, outcome.

More specifically, PBL tasks:

Use a problem that “appeals to human desire for resolution/stasis/harmony” and “sets up need for and context of learning which follows” (IMSA, 2005, p. 2).

Help students understand the range of problem-solving mechanisms available.

Focus on the merits of the question, the concepts involved, and student research plans.

Provide opportunities for students to examine the process of getting the answer (for example, looking back at the arguments).

Lead to additional “transfer” problems that use the knowledge gained in a different context.

Not every task necessarily exhibits all of these characteristics completely, but these lists can serve as guidelines for creating and evaluating tasks.

## Student benefits of problem-solving

There are many potential benefits of using PBL in classrooms at all levels; however, the benefits depend on how well this strategy is employed. With effective PBL, students can become more engaged in their learning and empowered to become more autonomous in classroom work. This, in turn, may lead to improved attitudes about the classroom and thus to other gains such as increased abilities for social-problem solving. Students can gain a deeper understanding of concepts, acquire skills necessary in the real world, and transfer skills to become independent and self-directed learners and thinkers outside of school. For example, when students are encouraged to practice using problem-solving skills across a variety of situations, they gain experience in discovering not only different methods but which method to apply to what kind of problem. Furthermore, students can become more confident when their self-esteem and grade does not depend only on the specific answer that the teacher wants. In addition, during the problem-solving process students can develop better critical and creative thinking skills.

Students can also develop better language skills (both knowledge and communication) through problems that require a high level of interaction with others (Verga & Kotz, 2013). This is important for all learners, but especially for ELLs and others who do not have grade-level language skills. For students who may not understand the language or content or a specific question, the focus on process gives them more opportunities to access information and express their knowledge.

## The problem-solving process

The use of PBL requires different processes for students and teachers. The teacher’s process involves

careful planning. There are many ways for this to happen, but a general outline that can be adapted includes the following steps:

After students bring up a question, put it in the greater context of a problem to solve (using the format of an essential question; see chapter 4) and decide what the outcome should be–a recommendation, a summary, a process?

Develop objectives that represent both the goal and the specific content, language, and skills toward which students will work.

List background information and possible materials and content that will need to be addressed. Get access to materials and tools and prepare resource lists if necessary.

Write the specific problem. Make sure students know what their role is and what they are expected to do. Then go back and check that the problem and task meet the objectives and characteristics of effective PBL and the relevant standards. Reevaluate materials and tools.

Develop scaffolds that will be needed.

Evaluate and prepare to meet individual students' needs for language, assistive tools, content review, and thinking skills and strategies

Present the problem to students, assess their understanding, and provide appropriate feedback as they plan and carry out their process.

The student process focuses more on the specific problem-solving task. PBL sources list different terms to describe each step, but the process is more or less the same. Students:

Define and frame the problem: Describe it, recognize what is being asked for, look at it from all sides, and say why they need to solve it.

Plan: Present prior knowledge that affects the problem, decide what further information and concepts are needed, and map what resources will be consulted and why.

Inquire: Gather and analyze the data, build and test hypotheses.

Look back: Review and evaluate the process and content. Ask "What do I understand from this result? What does it tell me?"

**FIGURE 6.1 Student Problem-Solving Process**

| Step | Example |
|---|---|
| 1. Define and frame the problem. | Determine what the problem is and why it is important to address. |
| 2. Plan. | Decide how to address the problem. |
| 3. Inquire. | Gather data and come to some conclusions. |
| 4. Look back. | Review and evaluate the conclusions. |

These steps are summarized in Figure 6.1.

Problem-solving strategies that teachers can demonstrate, model, and teach directly include trial and error, process of elimination, making a model, using a formula, acting out the problem, using graphics or drawing the problem, discovering patterns, and simplifying the problem (e.g., rewording, changing the setting, dividing it into simpler tasks). Even the popular KWL (Know, Want to Know, Learned) chart can help students frame questions. A KWL for a project asking whether a superstore should be built in the community might look like the one in Figure 6.2. Find out more about these strategies at http://literacy.kent.edu/eureka/strategies/discuss-prob.html.

Teaching problem-solving in groups involves the use of planning and other technologies. Using these tools, students post, discuss, and reflect on their joint problem-solving process using visual cues that they create. This helps students focus on both their process and the content. Throughout the teacher and student processes, participants should continue to examine cultural, emotional, intellectual, and other possible barriers to problem-solving.

FIGURE 6.2 KWL Chart

| Topic | What I Know | What I Want to Know | What I Learned |
|---|---|---|---|
| The economy of our town | | | |
| The political process fornew businesses | | | |
| How other towns like ours have been affected by superstores | | | |
| The impact of many low-paying jobs | | | |
| Noise, pollution, and traffic caused by superstores | | | |
| Benefits of having local shopping alternatives | | | |

Teachers and Problem-solving

The teacher's role in PBL

During the teacher's process of creating the problem context, the teacher must consider what levels of authenticity, complexity, uncertainty, and self-direction students can access and work within. Gordon (1998) broke loosely structured problems into three general types with increasing levels of these aspects. Still in use today, these are:

Academic challenges. An academic challenge is student work structured as a problem arising directly from an area of study. It is used primarily to promote greater understanding of selected subject matter. The academic challenge is crafted by transforming existing curricular material into a problem format.

Scenario challenges. These challenges cast students in real-life roles and ask them to perform these roles in the context of a reality-based or fictional scenario.

Real-life problems. These are actual problems in need of real solutions by real people or organizations. They involve students directly and deeply in the exploration of an area of study. And the solutions have the potential for actual implementation at the classroom, school, community, regional, national, or global level. (p. 3)

To demonstrate the application of this simple categorization, the learning activities presented later in this chapter follow this outline.

As discussed in other chapters in this book, during student work the teacher's role can vary from

director to shepherd, but when the teacher is a co-learner rather than a taskmaster, learners become experts. An often-used term for the teacher's role in the literature about problem-solving is "coach." As a coach, the teacher works to facilitate thinking skills and process, including working out group dynamics, keeping students on task and making sure they are participating, assessing their progress and process, and adjusting levels of challenge as students' needs change. Teachers can provide hints and resources and work on a gradual release of responsibility to learners.

### Challenges for teachers

For many teachers, the roles suggested above are easier said than done. To use a PBL approach, teachers must break out of the content-dissemination mode and help their students to do the same. Even when this happens, in many classrooms students have been trained to think that problem-solving is getting the one right answer, and it takes time, practice, and patience for them to understand otherwise. Some teachers feel that they are obligated to cover too much in the curriculum to spend time on PBL or that using real-world problems does not mesh well with the content, materials, and context of the classroom. However, twenty years ago Gordon (1998) noted, "whether it's a relatively simple matter of deciding what to eat for breakfast or a more complex one such as figuring out how to reduce pollution in one's community, in life we make decisions and do things that have concrete results. Very few of us do worksheets" (p. 2). He adds that not every aspect of students' schoolwork needs to be real, but that connections should be made from the classroom to the real world. Educators around the world are still working toward making school more like life.

In addition, many standardized district and statewide tests do not measure process, so students do not want to spend time on it. However, teachers can overcome this thinking by demonstrating to students the ways in which they need to solve problems every day and how these strategies may transfer to testing situations.

Furthermore, PBL tasks and projects may take longer to develop and assess than traditional instruction. However, teachers can start slowly by helping students practice PBL in controlled environments with structure, then gradually release them to working independently. The guidelines in this chapter address some of these challenges.

## GUIDELINES FOR TECHNOLOGY-SUPPORTED PROBLEM-SOLVING

Obviously, PBL is more than simply giving students a problem and asking them to solve it. The following guidelines describe other issues in PBL.

### Designing Problem-Solving Opportunities

The guidelines described here can assist students in developing a PBL opportunity.

Guideline #1: Integrate reading and writing. Although an important part of solving problems, discussion alone is not enough for students to develop and practice problem-solving skills. Effective problem-solving and inquiry require students to think clearly and deeply about content, language, and process. Reading and writing tasks can encourage students to take time to think about these issues and to contextualize their thinking practice. They can also provide vehicles for teachers to understand student progress and to provide concrete feedback. Students who have strengths in these areas will be encouraged and those who need help can learn from their stronger partners, just as those who have strengths in speaking can model for and assist their peers during discussion. Even in courses that do not stress reading and writing, integrating these skills into tasks and projects can promote successful learning.

Guideline #2: Avoid plagiarism. The Internet is a great resource for student inquiry and problem-solving. However, when students read and write using Internet resources, they often cut and paste directly from the source. Sometimes this is an innocent mistake; students may be uneducated about the use of resources, perhaps they come from a culture where the concept of ownership is completely different than in the United States, or maybe their language skills are weak and they want to be able to express themselves better. In either case, two strategies can help avoid plagiarism: 1) The teacher can teach directly about plagiarism and copyright issues. Strategies including helping students learn how to cite sources, paraphrase, summarize, and restate; 2) The teacher can be as familiar as possible with the resources that students will use and check for plagiarism when it is suspected. To do so, the teacher can enter a sentence or phrase into any Web browser with quote marks around it and if the entry is exact, the original source will come up in the browser window. Essay checkers such as Turnitin (http://turnitin.com/) are also available online that will check a passage or an entire essay.

Guideline #3: Do not do what students can do. Teaching, and particularly teaching with technology, is often a difficult job, due in part to the time it takes teachers to prepare effective learning experiences. Planning, developing, directing, and assessing do not have to be solely the teacher’s domain, however. Students should take on many of these responsibilities, and at the same time gain in problem-solving, language, content, critical thinking, creativity, and other crucial skills. Teachers do not always need to click the mouse, write on the whiteboard, decide

criteria for a rubric, develop questions, decorate the classroom, or perform many classroom and learning tasks. Students can take ownership and feel responsibility. Although it is often difficult for teachers to give up some of their power, the benefits of having more time and shared responsibility can be transformational. Teachers can train themselves to ask, “Is this something students can do?”

Guideline #4: Make mistakes okay. Problem-solving often involves coming to dead ends, having to revisit data and reformulate ideas, and working with uncertainty. For students used to striving for correct answers and looking to the teacher as a final authority, the messiness of problem-solving can be disconcerting, frustrating, and even scary. Teachers can create environments of acceptance where

reasoned, even if wrong, answers are recognized, acknowledged, and given appropriate feedback by the teacher and peers. Teachers already know that students come to the task with a variety of beliefs and information. In working with students' prior knowledge, they can model how to be supportive of students' faulty ideas and suggestions. They can also ask positive questions to get the students thinking about what they still need to know and how they can come to know it. They can both encourage and directly teach students to be supportive of mistakes and trials as part of their team-building and leadership skills.

In addition, teachers may need to help students to understand that even a well-reasoned argument or answer can meet with opposition. Students must not feel that they have made a bad decision just because everyone else, particularly the teacher, does not agree. Teachers can model for students that they are part of the learning process and they are impartial as to the outcome when the student's position has been well defended.

## PROBLEM-SOLVING AND INQUIRY TECHNOLOGIES

As with all the goals in this book, the focus of technology in problem-solving is not on the technology itself but on the learning experiences that the technology affords. Different tools exist to support different parts of the process. Some are as simple as handouts that students can print and complete, others as complex as modeling and visualization software. Many software tools that support problem-solving are made for experts in the field and are relatively difficult to learn and use. Examples of these more complicated programs include many types of computer-aided design software, advanced authoring tools, and complex expert systems. In the past there were few software tools for K–12 students that addressed the problem-solving process directly and completely, but more apps are being created all the time that do so. See the Teacher Tools for this text for examples.

Simple inquiry tools that help students perform their investigations during PBL are much more prevalent. The standard word processor, database, concept mapping/graphics and spreadsheet software can all assist students in answering questions and organizing and presenting data, but there are other tools more specifically designed to support inquiry. Software programs that can be used within the PBL framework are mentioned in other chapters in this text. These programs, such as the Tom Snyder Productions/Scholastic programs mentioned in chapter 2 address the overlapping goals of collaboration, production, critical thinking, creativity, and problem-solving. Interestingly, even video games might be used as problem-solving tools. Many of these games require users to puzzle out directions, to find missing artifacts, or to follow clues that are increasingly difficult to find and understand. One common tool with which students at all levels might be familiar is Minecraft (Mojang; https://minecraft.net/en-us/). The Internet has as many resources as teachers might need to use Minecraft across the disciplines to teach whole units and even gamify the classroom.

The following section presents brief descriptions of tools that can support the PBL process. The

examples are divided into stand-alone tools that can be used on one or more desktops and Web-based tools.

Stand-Alone Tools

Example 1: Fizz and Martina's Math Adventures (Tom Snyder Productions/Scholastic)

Students help Fizz and Martina, animated characters in this software, to solve problems by figuring out which data is relevant, performing appropriate calculations, and presenting their solutions. The five titles in this series are perfect for a one-computer classroom. Each software package combines computer-based video, easy navigation, and handouts and other resources as scaffolds. This software is useful in classrooms with ELLs because of the combination of visual, audio, and text-based reinforcement of input. It is also accessible to students with physical disabilities because it can run on one computer; students do not have to actually perform the mouse clicks to run the software themselves.

This software is much more than math. It includes a lot of language, focuses on cooperation and collaboration in teams, and promotes critical thinking as part of problem-solving. Equally important, it helps students to communicate mathematical ideas orally and in writing. See Figure 6.6 for the "getting started" screen from Fizz and Martina to view some of the choices that teachers and students have in using this package.

Example 2: I Spy Treasure Hunt, I Spy School Days, I Spy Spooky Mansion (Scholastic)

The language in these fun simulations consists of isolated, discrete words and phrases, making these programs useful for word study but not for overall concept learning. School Days, for example, focuses on both objects and words related to school. However, students work on extrapolation, trial and error, process of elimination, and other problem-solving strategies. It is difficult to get students away from the computer once they start working on any of the simulations in this series. Each software package has several separate hunts with a large number of riddles that, when solved, allow the user to put together a map or other clues to find the surprise at the end. Some of the riddles involve simply finding an item on the screen, but others require more thought such as figuring out an alternative representation for the item sought or using a process of elimination to figure out where to find it. All of the riddles are presented in both text and audio and can be repeated as many times as the student requires, making it easier for language learners, less literate students, and students with varied learning preferences to access the information. Younger students can also work with older students or an aide for close support so that students are focused. Free versions of the commercial software and similar types of programs such as escape rooms (e.g., escapes at 365 Escape {http://www.365escape.com/Room-Escape-Games.html] and www.primarygames.com) can be found across the Web.

There are many more software packages like these that can be part of a PBL task. See the Teacher

Toolbox for ideas.

Example 3: Science Court (Tom Snyder Productions/Scholastic)

Twelve different titles in this series present humorous court cases that students must help to resolve. Whether the focus is on the water cycle, soil, or gravity, students use animated computer-based video, hands-on science activities, and group work to learn and practice science and the inquiry process. As students work toward solving the case, they examine not only the facts but also their reasoning processes. Like Fizz and Martina and much of TSP's software, Science Court uses multimedia and can be used in the one-computer classroom (as described in chapter 2), making it accessible to diverse students.

Example 4: Geographic Information Systems (GIS)

The use of GIS to track threatened species, map hazardous waste or wetlands in the community, or propose solutions for other environmental problems supports student "spatial literacy and geographic competence" (Baker, 2005, n.p.), in addition to experimental and inquiry techniques, understanding of scale and resolution, and verification skills. Popular desktop-based GIS that students can access include Geodesy and ArcVoyager; many Web-based versions also exist. A GIS is not necessarily an easy tool to learn or use, but it can lead to real-world involvement and language, concept, and thinking skills development.

Web-Based Tools

Many technology-enhanced lessons and tools on the Web come premade. In other words, they were created for someone else's students and context. Teachers must adapt these tools to fit their own teaching styles, student needs, goals, resources, and contextual variables. Teachers must learn to modify these resources to make them their own and help them to work effectively in their unique teaching situation. With this in mind, teachers can take advantage of the great ideas in the Web-based tools described below.

Example 1: WebQuest

A WebQuest is a Web-based inquiry activity that is highly structured in a preset format. Most teachers are aware of WebQuests—a Web search finds them mentioned in every state, subject area, and grade level, and they are popular topics at conferences and workshops. Created by Bernie Dodge and Tom March in 1995 (see http://webquest.org/), this activity has proliferated wildly.

Each WebQuest has six parts. The Quest starts with an introduction to excite student interest. The task description then explains to students the purpose of the Quest and what the outcome will be. Next, the process includes clear steps and the scaffolds, including resources, that students will need to

accomplish the steps. The evaluation section provides rubrics and assessment guidelines, and the conclusion section provides closure. Finally, the teacher section includes hints and tips for other teachers to use the WebQuest.

Advantages to using WebQuests as inquiry and problem-solving tools include:

Students are focused on a specific topic and content and have a great deal of scaffolding.

Students focus on using information rather than looking for it, because resources are preselected.

Students use collaboration, critical thinking, and other important skills to complete their Quest.

Teachers across the United States have reported significant successes for students participating in Quests. However, because Quests can be created and posted by anyone, many found on the Web do not meet standards for inquiry and do not allow students autonomy to work in authentic settings and to solve problems. Teachers who want to use a WebQuest to meet specific goals should examine carefully both the content and the process of the Quest to make sure that they offer real problems as discussed in this chapter. A matrix of wonderful Quests that have been evaluated as outstanding by experts is available on the site.

Although very popular, WebQuests are also very structured. This is fine for students who have not moved to more open-ended problems, but to support a higher level of student thinking, independence, and concept learning, teachers can have students work in teams on Web Inquiry Projects (http://webinquiry.org/).

Example 2: Virtual Field Trips

Virtual field trips are great for concept learning, especially for students who need extra support from photos, text, animation, video, and audio. Content for field trips includes virtual walks through museums, underwater explorations, house tours, and much more (see online field trips suggested by Steele-Carlin [2014] at http://www.educationworld.com/a_tech/tech/tech071.shtml). However, the format of virtual field trips ranges from simple postcard-like displays to interactive video simulations, and teachers must review the sites before using them to make sure that they meet needs and goals.

With a virtual reality headset (now available for sale cheaply even at major department stores), teachers and students can go on Google Expeditions (https://edu.google.com/expeditions/), 3D immersive field trips from Nearpod (http://nearpod.com), and even create their using resources from Larry Ferlazzo's "Best Resources for Finding and Creating Virtual Field Trips" at http://larryferlazzo.edublogs.org/2009/08/11/the-best-resources-for-finding-and-creating-virtual-field-trips/.

Example 3: Raw Data Sites

Raw data sites abound on the Web, from the U.S. Census to the National Climatic Data Center, from

databases full of language data to the Library of Congress. These sites can be used for content learning and other learning goals. Some amazing sites can be found where students can collect their own data. These include sites like John Walker's (2003) Your Sky (www.fourmilab.to/yoursky) and Water on the Web (2005, waterontheweb.org). When working with raw data students have to draw their own conclusions based on evidence. This is another important problem-solving skill. Note that teachers must supervise and verify that data being entered for students across the world is accurate or

Example 4: Filamentality

Filamentality (https://keithstanger.com/filamentality.html) presents an open-ended problem with a lot of scaffolding. Students and/or teachers start with a goal and then create a Web site in one of five formats that range in level of inquiry and problem-solving from treasure hunts to WebQuests. The site provides lots of help and hints for those who need it, including "Mentality Tips" to help accomplish goals. It is free and easy to use, making it accessible to any teacher (or student) with an Internet connection.

Example 5: Problem Sites

Many education sites offer opportunities for students to solve problems. Some focus on language (e.g., why do we say "when pigs fly"?) or global history (e.g., what's the real story behind Tut's tomb?); see, for example, the resources and questions in The Ultimate STEM Guide for Students at http://www.mastersindatascience.org/blog/the-ultimate-stem-guide-for-kids-239-cool-sites-about-science-technology-engineering-and-math/. These problems range in level from very structured, academic problems to real-world unsolved mysteries.

The NASA SciFiles present problems in a format similar to WebQuests at https://knowitall.org/series/nasa-scifiles. In other parts of the Web site there are video cases, quizzes, and tools for problem-solving.

There is an amazing number of tools, both stand-alone and Web-based, to support problem-solving and inquiry, but no tool can provide all the features that meet the needs of all students. Most important in tool choice is that it meets the language, content, and skills goals of the project and students and that there is a caring and supportive teacher guiding the students in their choice and use of the tool.

Teacher Tools

There are many Web sites addressed specifically to teachers who are concerned that they are not familiar enough with PBL or that they do not have the tools to implement this instructional strategy. For example, from Now On at http://www.fno.org/toolbox.html provides specific suggestions for how to integrate technology and inquiry. Search "problem-solving" on the amazing Edutopia site (https://www.edutopia.org/) for ideas, guidelines, examples, and more.

## LEARNING ACTIVITIES: PROBLEM-SOLVING AND INQUIRY

In addition to using the tools described in the previous section to teach problem-solving and inquiry, teachers can develop their own problems according to the guidelines throughout this chapter. Gordon's (1998) scheme of problem-solving levels (described previously)—academic, scenario, and real life—is a simple and useful one. Teachers can refer to it to make sure that they are providing appropriate structure and guidance and helping students become independent thinkers and learners. This section uses Gordon's levels to demonstrate the variety of problem-solving and inquiry activities in which students can participate. Each example is presented with the question/problem to be answered or solved, a suggestion of a process that students might follow, and some of the possible electronic tools that might help students to solve the problem.

### Academic problems

Example 1: What Will Harry Do? (Literature)

Problem: At the end of the chapter, Harry Potter is faced with a decision to make. What will he do?

Process: Discuss the choices and consequences. Choose the most likely, based on past experience and an understanding of the story line. Make a short video to present the solution. Test it against Harry's decision and evaluate both the proposed solution and the real one.

Tools: Video camera and video editing software.

Example 2: Treasure Hunt (History)

Problem: Students need resources to learn about the Civil War.

Process: Teacher provides a set of 10 questions to find specific resources online.

Tools: Web browser.

Example 3: Problem of the Week (Math)

Problem: Students should solve the math problem of the week.

Process: Students simplify the problem, write out their solution, post it to the site for feedback, then

revise as necessary.

Tools: Current problems from the Math Forum@Drexel, http://mathforum.org/pow/

Scenarios

Example 1: World's Best Problem Solver

Problem: You are a member of a committee that is going to give a prestigious international award for the world's best problem-solver. You must nominate someone and defend your position to the committee, as the other committee members must do.

Process: Consult and list possible nominees. Use the process of elimination to determine possible nominees. Research the nominees using several different resources. Weigh the evidence and make a choice. Prepare a statement and support.

Tools: Biography.com has over 25,000 biographies, and Infoplease (infoplease.com) and the Biographical Dictionary (http://www.s9.com/) provide biographies divided into categories for easy searching.

Example 2: Curator

Problem: Students are a committee of curators deciding what to hang in a new community art center. They have access to any painting in the world but can only hang 15 pieces in their preset space. Their goals are to enrich art appreciation in the community, make a name for their museum, and make money.

Process: Students frame the problem, research and review art from around the world, consider characteristics of the community and other relevant factors, choose their pieces, and lay them out for presentation to the community.

Tools: Art museum Web sites, books, and field trips for research and painting clips; computer-aided design, graphics, or word processing software to lay out the gallery for viewing.

Example 3: A New National Anthem

Problem: Congress has decided that the national anthem is too difficult to remember and sing and

wants to adopt a new, easier song before the next Congress convenes. They want input from musicians across the United States. Students play the roles of musicians of all types.

Process: Students define the problem (e.g., is it that "The Star-Spangled Banner" is too difficult or that Congress needs to be convinced that it is not?). They either research and choose new songs or research and defend the current national anthem. They prepare presentations for members of Congress.

Tools: Music sites and software, information sites on the national anthem.

Real-life problems

Example 1: Racism in School

Problem: There have been several incidents in our school recently that seem to have been racially motivated. The principal is asking students to consider how to make our school a safe learning environment for all students.

Process: Determine what is being asked—the principal wants help. Explore the incidents and related issues. Weigh the pros and cons of different solutions. Prepare solutions to present to the principal.

Tools: Web sites and other resources about racism and solutions, graphic organizers to organize the information, word processor or presentation software for results. Find excellent free tools for teachers and students at the Southern Poverty Law Center's Teaching Tolerance Web site at www.tolerance.org.

Example 2: Homelessness vs. Education

Problem: The state legislature is asking for public input on the next budget. Because of a projected deficit, political leaders are deciding which social programs, including education and funding for the homeless, should be cut and to what extent. They are interested in hearing about the effects of these programs on participants and on where cuts could most effectively be made.

Process: Decide what the question is (e.g., how to deal with the deficit? How to cut education or funding for the homeless? Which programs are more important? Something else?). Perform a cost-benefit analysis using state data. Collect other data by interviewing and researching. Propose and weigh different solution schemes and propose a suggestion. Use feedback to improve or revise.

Tools: Spreadsheet for calculations, word processor for written solution, various Web sites and databases for costs, electronic discussion list or email for interviews.

Example 3: Cleaning Up

Problem: Visitors and residents in our town have been complaining about the smell from the university's experimental cattle farms drifting across the highway to restaurants and stores in the shopping center across the street. They claim that it makes both eating and shopping unpleasant and that something must be done.

Process: Conduct onsite interviews and investigation. Determine the source of the odor. Measure times and places where the odor is discernible. Test a variety of solutions. Choose the most effective solution and write a proposal supported by a poster for evidence.

Tools: Online and offline sources of information on cows, farming, odor; database to organize and record data; word processing and presentation software for describing the solution.

These activities can all be adapted and different tools and processes used. As stated previously, the focus must be both on the content to be learned and the skills to be practiced and acquired. More problem-solving activity suggestions and examples can be found at site at http://www.2learn.ca/.

## ASSESSING LEARNER PROBLEM-SOLVING AND INQUIRY

Many of the assessments described in other chapters of this text, for example, rubrics, performance assessments, observation, and student self-reflection, can also be employed to assess problem-solving and inquiry. Most experts on problem-solving and inquiry agree that schools need to get away from testing that does not involve showing process or allowing students to problem-solve; rather, teachers should evaluate problem-solving tasks as if they were someone in the real-world context of the problem. For example, if students are studying an environmental issue, teachers can evaluate their work throughout the project from the standpoint of someone in the field, being careful that their own biases do not cloud their judgment on controversial issues. Rubrics, multiple-choice tests, and other assessment tools mentioned in other chapters of this text can account for the multiple outcomes that are possible in content, language, and skills learning. These resources can be used as models for assessing problem-solving skills in a variety of tasks. Find hundreds of problem-solving rubrics by searching the Web for "problem-solving rubrics" or check Pinterest for teacher-created rubrics.

In addition to the techniques mentioned above, many teachers suggest keeping a weekly problem-solving notebook (also known as a math journal or science journal), in which students record problem solutions, strategies they used, similarities with other problems, extensions of the problem, and an investigation of one or more of the extensions. Using this notebook to assess students' location and progress in problem-solving could be very effective, and it could even be convenient if learners can keep them online as a blog or in a share cloud space.

FROM THE CLASSROOM

Research and Plagiarism

We've been working on summaries all year and the idea that copying word for word is plagiarism. When they come to me (sixth grade) they continue to struggle with putting things in their own words so [Microsoft Encarta] Researcher not only provides a visual (a reference in APA format) that this is someone else's work, but allows me to see the information they used to create their report as Researcher is an electronic filing system. It's as if students were printing out the information and keeping it in a file that they will use to create their report. But instead of having them print everything as they go to each individual site they can copy and paste until later. When they finish their research they come back to their file, decide what information they want to use, and can print it out all at once. This has made it easier for me because the students turn this in with their report. So, I would say it not only allows students to learn goals of summarizing, interpreting, or synthesizing, it helps me to address them in greater depth and it's easier on me! (April, middle school teacher)

WebQuests

I evaluated a WebQuest for middle elementary (third–fourth grades), although it seems a little complicated for that age group. The quest divides students into groups and each person in the group is given a role to play (a botanist, museum curator, ethnobotanist, etc.). The task is for students to find out how plants were used for medicinal purposes in the Southwest many years ago. Students then present their findings, in a format that they can give to a national museum. Weird. It was a little complicated and not well done. I liked the topic and thought it was interesting, but a lot of work would need to be done to modify it so that all students could participate. (Jennie, first-grade teacher).

CHAPTER REVIEW

Key Points

Define problem-solving and inquiry.

The element that distinguishes problem-solving or problem-based learning from other strategies is that the focal point is a problem that students must work toward solving. A proposed solution is typically the outcome of problem-solving. During the inquiry part of the process, students ask questions and then search for answers to those questions.

Understand the interaction between problem-solving and other instructional goals. Although inquiry is also an important instructional strategy and can stand alone, it is also a central component of problem-solving because students must ask questions and investigate the answers to solve the problem. In addition, students apply critical and creative thinking skills to prior knowledge during the problem-solving process, and they communicate, collaborate, and often produce some kind of concrete artifact.

Discuss guidelines and tools for encouraging effective student problem-solving.

It is often difficult for teachers to not do what students can do, but empowering students in this way can lead to a string of benefits. Other guidelines, such as avoiding plagiarism, integrating reading and writing, and making it okay for students to make mistakes, keep the problem-solving process on track. Tools to assist in this process range from word processing to specially designed inquiry tools.

Create and adapt effective technology-enhanced tasks to support problem-solving. Teachers can design their own tasks following guidelines from any number of sources, but they can also find ready-made problems in books, on the Web, and in some software pack-ages. Teachers who do design their own have plenty of resources available to help. A key to task development is connecting classroom learning to the world outside of the classroom.

Assess student technology-supported problem-solving.

In many ways the assessment of problem-solving and inquiry tasks is similar to the assessment of other goals in this text. Matching goals and objectives to assessment and ensuring that students receive formative feedback throughout the process will make success more likely.

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# 9
# Chapter 7 Supporting Student Production

Production is mentioned in the standards in every content area and also in the national standards for English language learners. Words like “compose,” “design,” “create,” “model,” “develop,”, and “report” are used to indicate that an important aspect of student learning across the content areas involves student products such as musical scores, written descriptions, models, multimedia presentations, posters, and role-plays. In science and social studies, as in math, music, and English, teachers and students are expected to use the production process to learn. Production projects also meet many of the other standards because they involve understanding, communicating, collaborating, and other learning goals.

## OVERVIEW OF TECHNOLOGY-SUPPORTED PRODUCTION IN K–12 CLASSROOMS

In order to support production effectively, teachers must understand why production is important and how it occurs.

### What Is Production?

Production is a form of learning whereby students create a product or a concrete artifact that is the focus of learning. Production is one kind of project-based learning; production can be seen as the process, and the product is typically the end result. There are many kinds of tasks used in classrooms, but not all of them result in a tangible product. For example, some tasks lead to new understandings, a discussion, or an action. In production projects, both the impetus and outcome of learning are a material object. In other words, a tangible, manipulable outcome is the driving force behind the development of each stage of the production project.

Products can take many forms, for example, a slide show, photographs, three-dimensional objects, or a portfolio (discussed further in chapter 8). They can range from essays to multimedia presentations to more elaborate productions. Good products are the result of communication, collaboration, creativity, and other student goals discussed in this book. Production is also a valuable activity in itself, particularly if the products are based in curriculum standards and support language and content

learning.

Because it is a relatively new teaching strategy for many classrooms and contains many elements of other strategies, and because it is hard to measure, research on production continues to develop. However, the theoretical support for project-based learning goes back to Dewey's idea (1938) of learning by doing, and the components of production have received a great deal of attention in the literature. Learning goals that can be included in the production process are widely supported in the literature as leading to gains in student achievement; for example, collaboration (discussed in chapter 3), problem solving (chapter 6), and critical thinking (chapter 4). In addition, active learning, or learning activities in which students do and think about what they do, has been found to be more useful for students than inert knowledge transfer (i.e., lecture). Active learning is more likely to be remembered and applied (Adams & Ray, 2016). In addition, as noted in several other chapters in this text, the literature shows that achievement will be greater if educational tasks and contexts are similar to real-life tasks and contexts. This means that authentic activities that are meaningful in students' lives support student achievement.

Overall, research exploring the use of project-based learning shows that students gain in subject matter, in skills and strategies worked on as part of the project, in problem-solving with groups and other work behaviors, and in attendance and attitude (George Lucas Foundation, 2005; San Mateo County Office of Education, 2001; Thomas, 2000). More important for some stakeholders in the educational process, some evaluations of project-based learning show student gains of more than 10% on statewide skills assessments (San Mateo County Office of Education, 2001).

Characteristics of effective production tasks

There is no one accepted model of project-based learning. In fact, it is implemented in so many different ways in classrooms that the distinctions between it and other learning activities are often blurred. The results of production activities can span the range from highly structured and prescribed outcomes, such as a written dialog with five lines that must contain certain vocabulary and grammatical items, to a very loosely controlled outcome, such as some type of new invention. During highly structured projects, students are provided with a clearly defined outcome, which they attempt to reproduce to the teacher's specifications; in loosely controlled projects, students are given a general area in which to produce and have many choices in the forms and features of their products.

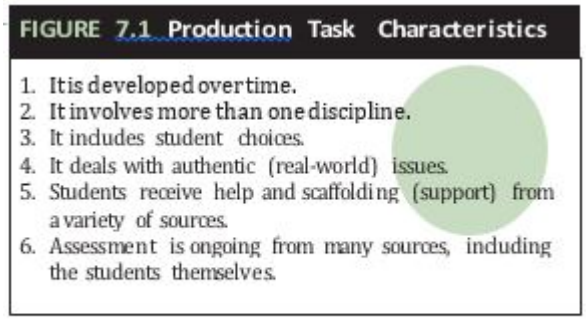


**FIGURE 7.1 Production Task Characteristics**

1. It is developed over time.
2. It involves more than one discipline.
3. It includes student choices.
4. It deals with authentic (real-world) issues.
5. Students receive help and scaffolding (support) from a variety of sources.
6. Assessment is ongoing from many sources, including the students themselves.

*Source:* Adapted from Bazeli, 1997; Blumenfeld et al., 1991; San Mateo County Office of Education, 2001.

The flexibility involved in creating production tasks means that teachers with different philosophies of teaching and learning can take advantage of production as a strategy. In the educational literature on production, characteristics of an effective production task generally include those in Figure 7.1

Student benefits of production

Production can serve as a motivator by engaging students in the process of their learning. Production

also allows students some leeway to work in ways that they prefer, helps them to develop real-world skills, and develops their abilities to communicate and collaborate with others. Most important for production projects, students are motivated by producing a tangible outcome. Like other types of group projects, well-planned production projects can result in the following student gains:

Individual and group/social responsibility

Planning, critical thinking, reasoning, and creativity

Strong communication skills, both for interpersonal and presentation needs

Cross-cultural understanding

Visualizing and decision making

Knowing how and when to use technology and choosing the most appropriate tool for the task (George Lucas Foundation, 2005)

Production projects can also benefit a wide range of students. For example, these projects can support the skills and abilities of English language learners. Production offers all students opportunities to communicate in a variety of modes (e.g., speaking, drawing, gesturing), to receive language and content input in a variety of modes (e.g., graphics, video, listening), and to use different learning styles (e.g., hands-on, visual, aural) during the production process. This helps ELLs to receive input in English that is comprehensible, to work in ways that they understand, and to play a role in the project regardless of their language fluency. Many benefits of project-based learning can be found in the Buck Institute for Education's 2013 document "Research Summary: PBL and 21st Century Competencies" at https://www.bie.org/object/document/research_summary_on_the_benefits_of_pbl.

In addition, the variety of tasks that are part of the production process, described in the following section, makes it easier to integrate students with different physical, social, and psychological abilities. Students can play roles that most suit their needs and aptitudes.

## THE PRODUCTION PROCESS

### What Is the Production Process?

Producing facilitates learning in many ways, but creating a product is not enough to promote effective learning. The production process is crucial to learning as students work to understand and make decisions about the product. During a production project, the three main stages are planning, development, and evaluation. These stages are similar to those used in other learning activities, but the focus here is on a product.

### The preproduction stage

In the preproduction or planning stage, students may help the teacher to uncover the features of a good product and develop rubrics and other evaluations to guide both process and product. Students construct a schematic that lays out in different ways the various steps in the project. They then conduct initial research, include finding information from print and electronic sources and evaluating existing products (if any). Students can also conduct interviews and plan other interactions with their intended audience. Students brainstorm, draw, discuss, demonstrate, and create a draft plan that includes roles for team members, tools needed, and a plausible timeline for each step. They use feedback from the teacher and other stakeholders to revise their plans as necessary.

### The production stage

During the production or development stage, students engage in direct creation, including designing, making models of their products, and performing the other tasks outlined in their plan. Teams use feedback from audience members and other stakeholders and the rubric criteria to form their product.

### The postproduction stage

During postproduction, or the evaluation stage, students reflect on feedback from their audience and on the process and product. They debrief, or discuss and reflect, individually, in teams, or as a class. The production process is not linear; rather, it is iterative in that students can repeat previous stages at any time as needed. In other words, if they find that they need to do additional planning or re-planning during the production stage, they can do so.

## Teachers and Production

### The teacher’s role in production projects

The teacher plays a crucial role in the success of production projects. It takes skill to plan well and keep the process running smoothly. The teacher’s role in projects can range from a very directive to a more facilitative role, depending on student level and abilities and the project goals. Teachers need to provide guidelines and models for what the product should be, not necessarily so that students can copy them exactly, but so that they realize what is expected and why. To keep students most active, teacher planning should include ways to have students make their own decisions and work closely with each other. The teacher can help students to identify roles and/or to disseminate them, provide clear goals and benchmarks, model both the language and content needed for the project, and provide ongoing feedback and skills lessons as students require them. However, not all students can work so autonomously and it is often difficult for teachers to loosen control; in these cases, a more structured project with a very specific product can be used.

### Challenges for teachers

In addition to the challenges of developing good projects, teachers may face school, community, and classroom obstacles to developing production projects. For example, projects often take time that standardized testing schedules or a rigid curriculum do not permit. Some teachers (or administrators) cannot abide noisy classrooms or relinquishing control to students. Another challenge for teachers is to understand how to provide enough scaffolding, or assistance, as students need it without interfering too much; they might also have to learn new technologies and learn how to assess the process and the product. All these challenges can be overcome with time and practice. The guidelines, tools, and resources mentioned in the next section can help teachers understand how to avoid or work through these challenges.

## GUIDELINES FOR SUPPORTING STUDENT PRODUCTION

### Guidelines for Designing Production Opportunities

In carefully planned projects, students understand the process and understand that the technology is secondary in importance to the content and goals of the project. Students are active learners; they make decisions, ask questions, write dialog, draw, direct, suggest, critique, and disagree. Students have the opportunity to play many different roles. Students who are not as competent in one area, for example, students whose language proficiency is not at grade level or those who have difficulty performing certain tasks, have the opportunity to work in other areas. However, the work of all students is valued and none of the students is exempt from working toward the final goal. By requiring that learners ask each other for help and evaluate one another's work, the teacher provides frameworks of support (scaffolding) and guides learners to use valuable resources (their peers). Some of the guidelines for designing effective production projects are discussed here.

Guideline #1: Focus on process. This is important because often while creating projects, learners may get caught up in the graphics and other "fun" parts of production and lose some of the project's opportunities for learning. Teachers must ensure that the task is devised so that students focus on the use of the language and content that are to be learned and used. Designing opportunities means:

Establishing both language and content goals that students understand

Involving students in the evaluation of content and process

Helping all students be actively involved in every aspect of the project

To help students get the most out of the process, the teacher can assign teams roles for each stage of the infomercial project. Students should be familiar with these roles because they have used them before. Each stage can have, for example, a Technology Operator, an Editor, a Team Liaison, and an Idea Generator. Team members redistribute the roles for each stage of the project so that all students have a chance to work to their strengths and also improve on their weaknesses. At each stage, the teacher, the school technology coordinator, and the library media specialist can work with an expert group (one member of each team) in a form of "cascade learning" to train students who are playing the

role of Technology Operator. In different stages, for example, the Technology Operator is responsible for Internet searching, the digital camera, the editing software, and word processing. In each stage a different student is the Editor, who is responsible for both editing text documents and completing project paperwork. A third team member, who serves as the Team Liaison, works with other students and the teacher as a representative of the team, and an Idea Generator leads the development of the different stages of the project.

By focusing on all students being actively involved with content and language, teachers can assist learners in completing a process that will meet their goals and result in a useful product. ELL students, even those not at grade level in reading and writing, can be very successful at learning and teaching the technologies, generating ideas, and working as Liaison. These students can be encouraged to take on the role of Editor in the last stage of the project when they are familiar with the vocabulary, ideas, and tasks involved in the project. In this way, teachers can help them work from their strengths to developing their weaknesses while still holding them accountable for each part of the task.

Guideline #2: Use an authentic audience. Research on student production shows that students work harder when their work will be viewed by others. However, publishing student products for only the teacher to view generally is not enough to support this kind of motivation and effort. Instead, learners need an audience that is external to the immediate classroom and that cares about and has knowledge of the product, because such an audience will provide useful, authentic, and effective feedback. The audience should also be able to engage in interaction around both the process and the product and should clearly understand their roles in the project. Finding such an audience can be a difficult task, but it is one that students and teacher can share. For example, students might suggest that their reports on the first Gulf War be read by veterans of that conflict. The teacher can ask for volunteers from a veterans' electronic list or a local veterans organization. Remember that providing student products to an authentic audience in the public sector, for example, on a Web site that has open access, means that safety and other issues must be considered (these issues are discussed in chapter 3).

Guideline #3: Teach the tools. It is important that students understand how to use the computer tools that might help them in their production process. Students do not need to understand every component of the program, but the salient features that support their current process should be clear. This information, like all important content, should be presented in a variety of ways for all learners to access the instructions: graphically, orally, and in written form, at a minimum. ELLs and other students who may need extra help to understand have more chance to comprehend when the information is presented in many ways. Multimodal presentation also addresses the different student learning preferences present in every classroom. The teacher can decide to use expert groups to teach the technologies that her students need for their projects, such as video editing, word processing, disk burning, graphics, and downloading or copying clip art from the Internet. She can teach a subset of the students and they, as experts, teach other students in the class. Because each stage of the project requires different skills and tools, all students have a chance both to be the expert and to learn about different technologies from their peers. Students might see this as just another part of the project, but

the teacher knows the power that students feel when they are allowed to be experts and how teaching others leads to greater learning. To deal with the challenge to learn the technologies for each stage of the project,

The teacher can call on part of the support network in the school, the information technology coordinator and library media specialist, to teach each group's current Technology Operator. This way, the teacher learns as the students learn rather than trying to figure out multiple tools herself before the project begins.

Guideline #4: Understand the tools. It is important that students know not only how to use the tools but also that they understand the opportunities that each tool affords. To this end, teachers and learners can brainstorm the kinds of tasks that can be accomplished with tools such as a database program, a word processor, or a graphical organizer. For example, if students were to produce a newspaper, they would need to understand that graphical organizer software could help them brainstorm and lay out a process, but it could not help to format the newspaper in the way that a word processing or desktop publishing program could. Teachers and their students can consider how the use of the tools limits or structures what they can produce, and they can continue to add to the list over time so that students use tools that provide them the most effective opportunities for producing content and language.

Guideline #5: Scaffold experiences for all learners. Some students, such as ELLs and students with disabilities, may need extra time, help, and modeling while working on projects. To facilitate their understanding, teachers can present information about project instructions, goals, and outcomes in a variety of modes (written, oral, visual), as described previously. Presenting guidelines and tasks in multiple modes provides opportunities for English language learners and those with special needs to receive content and language input in a variety of ways and helps to support comprehension; it also addresses the needs of students who prefer to learn in diverse ways.

In addition, as in any effective learning experience, projects should start with learners' knowledge in content, language, and technology and build from there. Teachers can provide scaffolds by breaking up the task into logical stages; encouraging students to use a variety of re- sources in different modes such as writing, graphics, and oral language; and providing examples and models during the process.

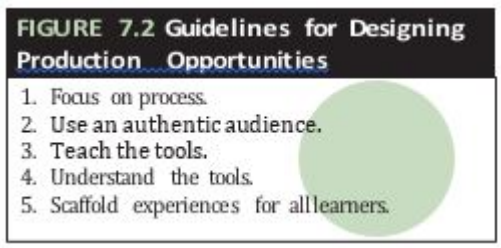



Figure 7.2 presents a summary of the guidelines for designing production opportunities.

## TECHNOLOGIES FOR SUPPORTING PRODUCTION

### What Are Productivity Tools?

Students can use a variety of tools in creating their media projects, all of which are suited to a particular stage or process. Productivity tools are those that maximize or extend students' ability to create products, solve problems, and express themselves. With productivity tools, students can construct models, publish, plan and organize, map concepts, generate materials, collect data, and develop and present their work. Electronic productivity tools include hardware such as digital cameras and video recorders and many different kinds of software. Many teachers are familiar with at least some of the commonly used productivity software.

It is important to note that the production process does not inherently require the use of technology. Rather, technology is used as it fits into the plan and makes the process more effective and/or more efficient. In developing activities that result in a student product, teachers and students should reflect on why they might use technology during the process. As discussed earlier in this book, if the technology does not make the teaching and learning more effective or more efficient, other tools should be considered.

There are many examples in each category of production tools, including some that are made specifically for different student grade and ability levels. Different schools and class- rooms may have entirely different sets of these tools, but they work in similar ways. The tools do not necessarily make learner products better or more creative, but they can be more professional and easier to share with others. Some research shows that learners are encouraged to produce more while using such tools. The more output students produce, the more opportunities they have to learn both content and language. Check this text's Teacher Toolbox for specific production tools.

### Student examples

Student iMovie products in a number of content areas can be found across the Internet. Art, English, math, science, music, and social studies projects are represented. Many sites also include tips from teachers, including using iMovie in the science classroom and making commercials with iMovie.

Likewise, interesting projects at all school levels using PowerPoint in a variety of content areas, along with hints and tips on using PowerPoint in the classroom, can be found by searching "PowerPoint projects" + (grade level).

### Tools for teachers

Productivity tools also provide opportunities for teachers. Grading programs and worksheet and puzzle-making software assist teachers in creating products to use in their classes and in being more effective in their instruction (see chapter 9 for more on teacher tools).

### Overcoming challenges

With all the guidelines to follow and possible challenges to face, teachers might find creating and using production projects supported by technology overwhelming at this point. However, if teachers build on standards for content and language learning, focus on the process, provide effective scaffolds, and encourage the principled use of technology (in other words, grounded in research, standards, and effective practice), they can create an almost limitless number of possibilities for projects that can be effective learning experiences. In addition to those presented in the following section, activities in other chapters throughout this text also support production.

## LEARNING ACTIVITIES: PRODUCTION PROJECTS

The production projects described here are not addressed to specific grade or language levels— those for which they are appropriate is a choice that the teacher, knowing her students well, can make. Instead, the multidisciplinary activities are grouped initially by the content area that is most central to the project. Sample emphases for goals in both content and language are provided for each project; these are the focus of task development and tool use. After the product is presented, the examples in each content area are divided into one of three technology categories. Examples in each content area include

One that employs basic technologies (those that involve simple or few features that are generic across many tools)

One that uses relatively more sophisticated technologies (those that require additional features or multiple tools or are relatively new)

One that could use advanced technologies (those that require more in-depth knowledge of the tool or tools that are more complicated).

This format demonstrates that production is not a result of the technology used, but that the technology use is based on the task goals and structure.

The project descriptions do not state the teacher’s role, the challenges that teachers may face, how scaffolding should be done, or specific name brands for each project. Think about these aspects as you read the project descriptions, and be prepared to answer the question at the end of this section.

### English

Content and language goals: Culture, media, adjective use, descriptive writing

Product: Movie flyer

Basic technologies: Word processor or simple graphics program Students complete the following process:

Review movie flyers and advertisements.

Choose a theme for a movie that they would like to see.

Develop text about their movie that fits with the genre.

Use a word processor to type their text and use appropriate fonts and styles, leaving room for any photos or graphics.

Add fonts/graphics.

Work with other students to review and revise their poster.

Students can produce very inventive products in this project. Follow up by posting the flyers around the room and letting students comment on which movies they might like to see and why.

Content and language goals: Genres, elements of story, peer editing

Product: Digital montage

Sophisticated technologies: Word processor, simple authoring program, presentation program, digital camera (optional)

Students work in cooperative groups to:

Develop themes or stories in a chosen genre.

Develop auto-play presentations with graphics, sound, and text.

Edit with peers.

Share with the intended audience.

These tools permit a fairly basic montage, typically slide by slide. Classes of younger children often make a very authentic audience for this activity.

Content and language goals: Summary, dialog, culture, text comprehension

Product: Five-minute movie trailer

Advanced technologies: Word processor, digital editor, CD burner and software, digital cameras/ video

recorders

Students work together to:

Create the script for a five-minute movie based on a book they have read.

Develop costumes and scenery as needed.

Film the movie.

Edit the movie and burn it to a CD or DVD or post to a safe video site.

Share the movie with the intended audience.

The moviemaking/video editing software seems to be a sophisticated technology, but it is actually easy to use—it can be expensive, however, and many people tend to associate expensive technologies with higher levels of technical skill. Avid DV is free video editing software for the PC, as is iMovie for Apple/Macintosh computers. This activity is an excellent assessment and provides a different take on post-reading activities.

Social studies

Content and language goals: Idioms, slang, humor, current events/ politics

Product: Magnets and bumper stickers

Basic technologies: Word processing or presentation software with magnet or bumper sticker paper

After researching and discussing a current event and related language, students:

Develop a slogan or saying, explain the meaning and purpose of the slogan.

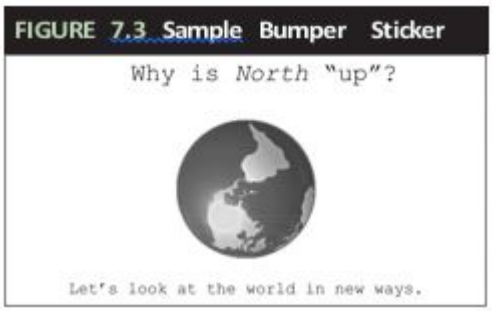
Revise based on classmates' or others' comments.

Type their sayings into a word processor and print.

Display for an appropriate audience.

Even students with less advanced English proficiency can come up with some witty and thoughtful sayings for this activity. Other content areas can also make use of this kind of task. See Figure 7.3 for an example of a bumper sticker that questions the "top-down" view of maps and globes.

FIGURE 7.3 Sample Bumper Sticker




Content and language goals: Reporting, five W's (who, what, where, when, and why), historical facts, extrapolation

Product: Simple newsletter for a historical organization

Sophisticated technologies: Desktop publishing software, Web search engines, scanner

Creating a newsletter is a common activity in many classes in which students:

Collect historical information from both electronic and print resources.

Type their articles using a word processor.

Include whatever graphics are necessary, using a scanner if available.

Edit, headline, and lay out the articles.

Print, copy, and deliver the newsletter to relevant readers.

Simple newsletters are often the most interesting. This activity includes many different roles that can assist ELLs and other students who need extra time or feedback to complete their tasks.

Content and language goals: Reported speech and other genres, current events, humor, titles

Product: A newspaper, complete with political commentary, cartoons, features, and ads

Advanced technologies: Depends on content, but a desktop publishing package, graphics package, word processor, digital image editing software, and others could be used.

Students

Create and assign job responsibilities.

Collect historical information from print, electronic, and human resources.

Create their part of the newspaper using appropriate technology.

Work with team members to revise and improve their work.

Edit; write headlines, captions, bylines; and design the layout.

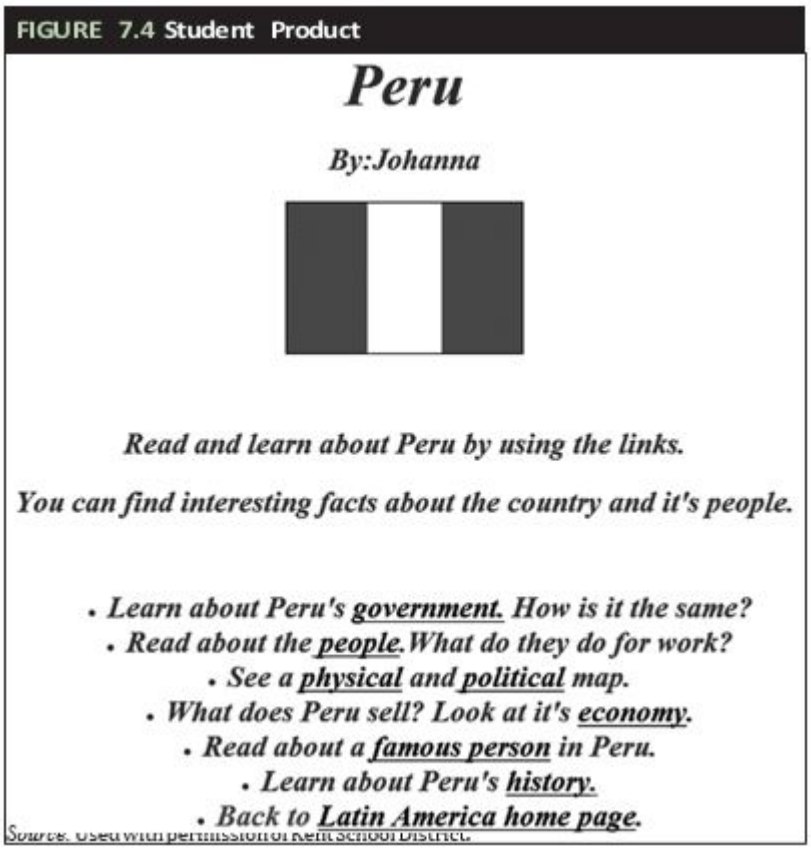
Print, copy, and deliver; solicit feedback.

Students can publish more than one issue during a semester, or use the one issue as a springboard for additional projects and discussion. Roles can change during the additional issues as students learn and become more comfortable with different language and tasks.

Social Studies Sample: Latin America Projects

Sixth-grade students in Washington State's Kent School District present their Latin American projects at http://www.kent.k12.wa.us/. The products are simply designed examples of research that the students did to explore countries in Latin America. Figure 7.4 presents an example of one student's product.

FIGURE 7.4 Student Product




Source: Used with permission of Kent School District.

Science

Content and language goals: Descriptive language, inventions

Product: New invention

Basic technologies: Word processing, paint program (optional).

During a unit on inventors, learners:

Design a new invention that they would like to use.

Type a clear and complete description of the invention.

Have another student try to draw their invention from the description.

Revise.

Post so that other students can try to draw it.

Compile the drawings and descriptions into a catalog.

This activity allows learners to write as much or as little as they can and practice process writing while focusing on science content. The catalog can be used for a variety of follow-up activities, such as writing stories about the new inventions, calculating costs of making the product, and so on.

Content and language goals: Patents, inventions, persuasive language, descriptive language

Product: Patent application

Sophisticated technologies: Desktop publishing software, graphics software, scanner.

In teams, students:

Explain their inventions clearly in text, comparing them to existing inventions as necessary.

Draw their inventions, scan, and import their pictures to their application document.

Complete a patent application form.

Receive feedback from evaluators (e.g., local experts, the teacher, other students) who decide which should be awarded patents and which need more work and why.

Revise.

Students can have roles that help them to perform their project tasks.

Content and language goals: Instructions, imperatives, inventions, and inventors

Product: A WebQuest

Advanced technologies: An electronic encyclopedia, word processing and graphics software, HTML editor, or Web page creation software

After working with WebQuests, student teams:

Review criteria for WebQuests.

Download appropriate templates from Bernie Dodge’s WebQuest site at http://webquest.org (see Figure 7.5).

Develop a plan for creating a science WebQuest.

Design each section, using and including appropriate resources.

Complete and post their WebQuests for evaluation.

**FIGURE 7.5 Part of a Generic WebQuest Template**

Put the Title of the Lesson Here

A WebQuest for_____th Grade
(Put Subject Here)

Put some interesting graphic representing the content here

Designed by Put Your Name Here

Put Your E-mail Address Here

Introduction | Task | Process | Evaluation | Conclusion | Credits | Teacher Page

***Introduction***

This document should be written with the student as the intended audience. Write a short paragraph here to introduce the activity or lesson to the students. If there is a role or scenario involved (e.g., "You are a detective trying to identify the mysterious poet.") then here is where you'll set the stage. If there's no motivational intro like that, use this section to provide a short advance organizer or overview.

Remember that the purpose of this section is to both prepare and hook the reader. It is also in this section that you'll communicate the Big Question (Essential Question, Guiding Question) that the whole WebQuest is centered around.

***Task***

Describe crisply and clearly what the end result of the learners' activities will be. The task could be a:

- problem or mystery to be solved;
- position to be formulated and defended;
- product to be designed;
- complexity to be analyzed;
- personal insight to be articulated;
- summary to be created;
- persuasive message or journalistic account to be crafted;
- a creative work, or
- anything that requires the learners to process and transform the information they've gathered.

If the final product involves using some tool (e.g., HyperStudio, the Web, video), mention it here.

*Source:* Used with permission of Bernie Dodge, San Diego State University.

Student teams can also choose one segment of a whole-class WebQuest project to work on, or they can improve a WebQuest that they have participated in.

Science Sample: International Clean Communities Project

In one science-based project, secondary students in Belarus and the United States worked together online and traveled to work face to face to understand waste management around the world and increase communication between these countries about environmental issues. One outcome from their project was student-made posters addressing their concerns. Figure 7.6 presents examples of the posters produced by the students

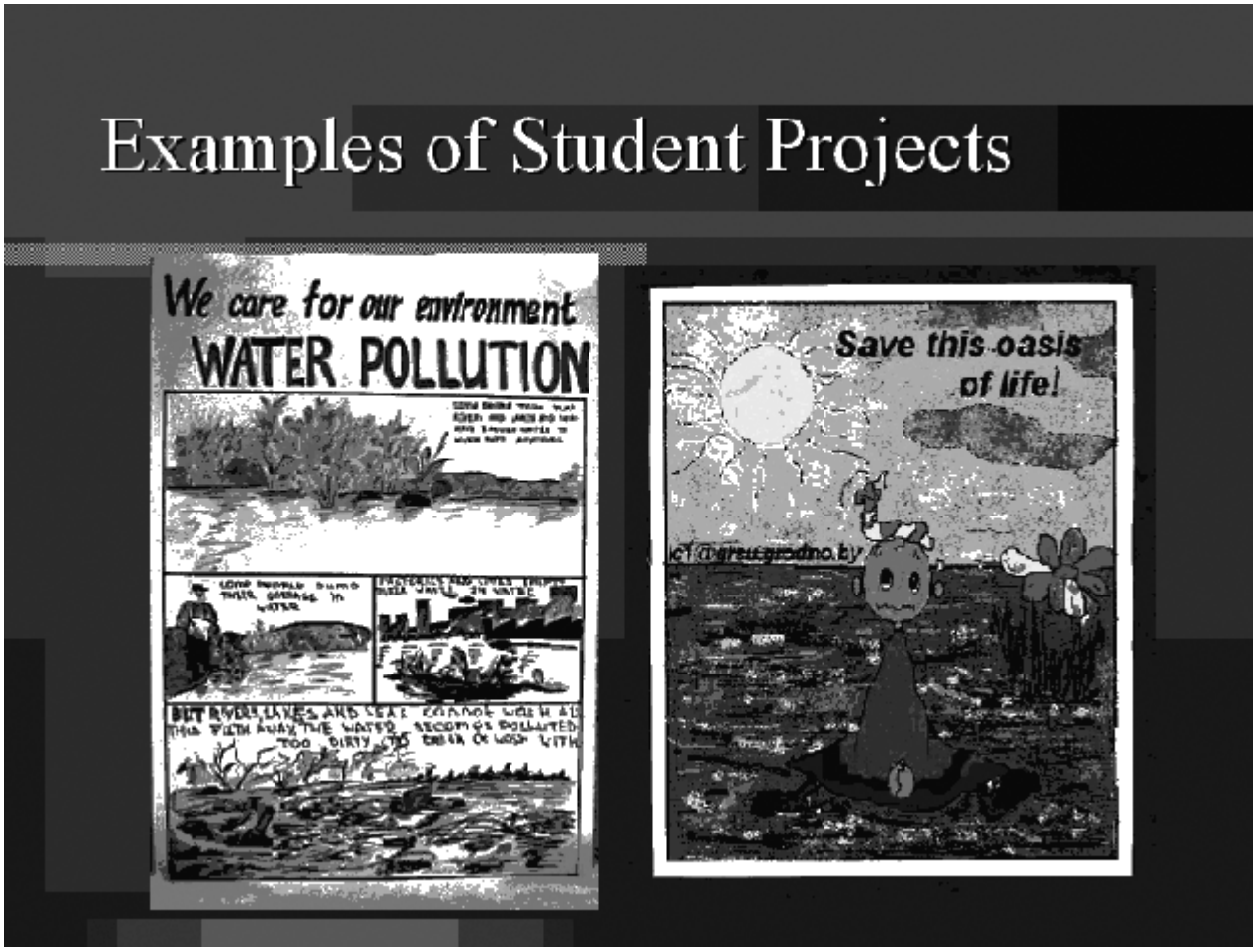



**FIGURE 7.6 Examples from the Clean Communities Project**

Math

Content and language goals: Connectors, story writing, discussion, word problems

Product: Action mazes

Basic technologies: Presentation software or a word processor (can also be done in a web site builder or with an authoring program)

In an action maze, students must solve math puzzles and choose the correct answer to follow a story line. To make their own action mazes, in collaborative groups, students:

Decide on a math focus, content topic, and layout for their maze.

Write the text and decide how it will branch at decision points.

Find or create necessary graphics.

Create the maze in an authoring program.

Share it with peers.

Producing and using action mazes (Egbert, 1995; Healey, 2002; Holmes, 2002) can facilitate discussion, collaboration, and creativity in both the creators and the users.

Content and language goals: Question formation, percentage, graphs, reporting

Product: Peer survey

Sophisticated technologies: Spreadsheet

Students choose an issue that is important to them and:

Design a survey to gather student opinions.

Interview peers or other target audience.

Use a spreadsheet to calculate results and make graphs.

Present the results to the administration or other authentic audience.

Students can propose a new traffic light in front of the school, additions to the cafeteria offerings, or new books for the school library while working on math content and language.

Content and language goals: Area, house vocabulary, measurement

Product: House design

Advanced technologies: A computer-aided design program. The teacher assigns a specific total house area, and students:

Brainstorm and/or research the kinds of rooms and their relative sizes that people might want in a home.

Work with the CAD program to create their house to the specifications.

Revise to meet the total house area given.

Present the house plan to an authentic audience.

By creating and producing with other students who have different backgrounds and ideas, learners improve their content knowledge and language abilities while also increasing their cultural capital.

Student Samples: High Tech High

For examples of student work that integrates math across the curriculum, see the student projects page of High Tech High (https://www.hightechhigh.org/student-work/student-projects/). From baking bread to community study, elementary through high school students are putting math and technology to work in amazing ways.

Production projects can also be designed to address specific topics and language areas. Following are examples of language skills and vocational skills learning.

Language skills

Content and language goals: Vocabulary, definitions, spelling

Product: Puzzle

Basic technologies: A puzzlemaker program. Students use the vocabulary under study and:

Choose a puzzle type.

Create the puzzle text (typically clues or definitions for each word).

Create the puzzle.

Share it with peers.

Students are active when the teacher allows them to take responsibility for their learning, including creating opportunities for practice and assessment.

Content and language goals: Story elements, sentence formation, cohesive devices

Product: A book

Sophisticated technologies: A book publishing program

Students work with a given topic or develop one of their own into a book.

Students:

Complete a storyboard with text and possible graphics (a sample storyboard is shown in Figure 7.8).

Revise for grammar and surface features.

Create the title, text, and graphics in the software.

Edit as necessary.

Students can share their books with parents or students in another class or grade level. Using software available for different technical levels and language abilities can make this project easy and structured.

**FIGURE 7.8 A Sample Storyboard**

| | | |
|---|---|---|
| Visual: | Visual: | Visual: |
| Text: | Text: | Text: |
| Visual: | Visual: | Visual: |
| Text: | Text: | Text: |

Content and language goals: Question and statement formation, explaining

Product: Interactive quizzes

Advanced technologies: A Web page composer program or another authoring/authorable software package.

Working alone or in groups, students:

Choose the format, questions, and answers for their quiz and decide on the type of feedback to be provided.

Create their quiz.

Give their quiz and take those that other students have made to study for the teacher’s version.

Like the simpler puzzlemaker, the products in this project help students study, practice, and review. They can also reinforce correct answers and help learners to understand plausible mistakes.

Vocational skills (community/business)

Content and language goals: Occupations, small talk, future verb tense

Product: Business cards

Basic technologies: Simple word processor Students prepare for their possible futures and:

Think about what they might like to be when they are older.

Decide on the company and location where they want to work (authentic or fictitious).

Design a business card with their name and work information and print on precut business card stock (see an example in Figure 7.9).

Role-play their business selves and hand out business cards to their peers.

FIGURE 7.9 A Sample Student Business Card


This project is great for English language learners because it does not require much text and it provides practice in small talk.

Content and language goals: Résumé content, book characters, business language, past tense, formatting

Product: Résumé

Sophisticated technologies: Advanced word processing features or desktop publishing program.

In this multidisciplinary project, students:

Answer questions on a character or author's life. The questions require them to discover information typically required for résumés.

Create their character's résumé using a word processor.

Compare to the work of others who have chosen the same character, or check with someone who knows the character.

Revise the résumé.

Present their character to the class.

This activity facilitates extensive interaction among students and helps students to understand elements of resumes and of literature.

Content and language goals: Question formation, business register, surveying, calculating

Product: A business (bake sale), including business cards, a survey, a schedule, advertisements

Advanced technologies: Spreadsheet, advanced word processing features, graphics package

Students, with members of the school parent or student organization:

Decide on business type and create and distribute roles to each student.

Make business cards.

Create a survey asking students at the school their preferences (for favorite bake-sale cookie types or whatever the business will be).

Enter the numbers into a spreadsheet and calculate percentages.

Decide on what will be sold and when, how advertising will be done, and other issues.

Create the advertising and the product.

Sell it.

Measure their success by comparing survey results to actual sales.

As long as schools have bake sales, they can be used for learning purposes. In this activity, all students have many choices of how to work, which supports diverse abilities and skills.

Adapting Activities

The steps presented in each project are suggestions and can be adapted in many ways. Some of these activities can also be done using non-electronic technologies such as pencil and paper. However, in most cases the use of technology adds to the process by giving the products a professional appearance and giving students more time and more resources for creating and learning. In addition, teaching learners through and about technologies can help them accomplish many language and content goals while also learning valuable technology skills.

The examples above are only a few of the activities that facilitate production, and thereby content and language learning. There are others throughout this text and more examples can be found all over the Web. Teachers who want to design their own effective production activities should keep in mind the principles and standards from chapter 1 and also reflect on the process that students will use as they produce. All of the projects can be adapted to use different technologies and to work in different

contexts. Even the most sophisticated products can often be completed with basic technologies, although the products will be different in some ways. These examples also illustrate what great products can come from simple technologies and how goals can be met effectively through production.

## ASSESSING PRODUCTION PROJECTS

Evaluating production projects can be different from evaluating other kinds of projects in that one major outcome is tangible; however, it is similar in that both process and product must be evaluated to provide a true understanding of the learning that has occurred. Evaluating the process and product means that teacher and students must be involved in ongoing assessment throughout the project.

Teachers and students can use one, more than one, or all of these assessments for project- based learning:

FIGURE 7.10 Infomercial Checklist

**Infomercial Checklist**

We have completed these tasks for our infomercial:

___ Made a plan
___ Considered our audience
___ Reviewed models
___ Wrote the script
___ Checked our sources
___ Edited the script
___ Checked the script with another team
___ Filmed our infomercial
___ Edited our infomercial

Our infomercial:

___ Is about 5 minutes long
___ Shows the product
___ Uses advertising language
___ Uses good grammar
___ Is exciting

Team activity reports—These can be written or oral, individual or group, and explain what the group and/or individual has been doing and what help they need to continue. One team activity report is an infomercial checklist, as seen in Figure 7.10. Notice that this assessment helps students to practice language, in this case past and present tense. ELLs and others who need to work on basic language skills are supported by the simple language used in this assessment.

Peer teamwork reports—Students report on how the collaborative process is working, where it breaks down, and what they are learning by working with their team. These reports can take any number of forms; Figure 7.11 shows one possibility for n infomercial project.

Self-assessment—Students can be asked to describe their progress and outcomes according to the rubric criteria, or they can be asked to reflect on how well and in what ways they participated in their group. Students could be asked in which role they performed the best, in which they achieved the most, which role was most difficult and why, and which they preferred. This information will help students assess their strengths and weaknesses and the teacher to plan future projects.

**FIGURE 7.11 Teamwork Report for Infomercial Project**

Teamwork Report—Stage 2

In my group I:

| | | | |
|---|---|---|---|
| 1. Listened actively | Usually | Sometimes | Never |
| 2. Asked questions | Usually | Sometimes | Never |
| 3. Gave ideas | Usually | Sometimes | Never |
| 4. Agreed or disagreed | Usually | Sometimes | Never |

By working with my group, I can do something that I could not do before:

In group work I still need to improve on this:

Teams assess each other—This can be formal or more informal and based on general criteria or on whatever teams find to comment on. During an infomercial project, the teams can assess each other informally based on what they see as strengths and weaknesses in other teams' scripts. Teams can comment, for example, on the interest that the script generates, others how well written it is, and yet others how clearly the product is described.

Outside stakeholders—External reviewers can create their own criteria for the product or use criteria provided by the teacher.

These assessments can take place orally, in written form, or both. Students, such as some ELLs who are unable to respond in these formats, can draw pictures or present their information in other ways.

FROM THE CLASSROOM

Projects

I use a lot of projects as a means to teach concepts. This approach works for me, because I can have the same basic thing that all kids are doing, but adjust expectations or requirements depending on students' various abilities. I feel that the projects give the kids problems to solve and help encourage critical thinking. I also think projects on the computer that require students to make an end product really encourage this as well. The computer projects have been great for my ELLs. (Susan, fifth-grade teacher).

Roles

I have used the strategy of assigning roles to students for group work. I've used it in the middle school and with adults. You may choose to play a smaller part in this and list the different roles on the board: time keeper, recorder, etc., and have students decide who will do what in their group. Assigning roles also eliminates the possibility of hitch-hikers, students who just go along with everything and don't contribute. For younger students I would have jobs assigned at random or make smaller groups with fewer roles. Just simplify it and it will still be successful.

Rotating also helps everyone participate in the different types of roles available, which you can alter according to your lesson plans and expected outcomes. (Gabriela, second-grade teacher).

CHAPTER REVIEW

Key Points

Define production.

Production is the development, through a process, of a tangible, manipulable outcome (a product). The product is the impetus behind the development of each stage of the production project.

Describe the benefits of student production for learning.

The benefits of student production for learning include student gains not only in language and content but also in social skills, critical thinking and planning, communication, cultural knowledge, and evaluation.

Explain the role of process in production.

The production process is a carefully designed process and crucial for the success of the project. Planning, development, and evaluation are three general stages in the production process.

Discuss guidelines for supporting student technology-enhanced production.

Teachers need to focus on the process, provide authentic audiences to view student work, understand and teach the tools, and provide scaffolds for students. In addition, the teacher's role varies from project director to project guide depending on the structure and goals of the project. Research supports the use of production for student learning, although there are challenges for teachers, students, and administrators in designing and carrying out production projects.

Describe technologies for supporting student production.

Tools such as word processors, spreadsheets, draw programs, and presentation software can support production. The use of production tools alone, however, does not result in learning. As noted above, production projects must be carefully planned so that they meet both con- tent and language objectives and support other learning goals.

Evaluate and develop pedagogically sound technology-enhanced production activities. A wide range of products can fit a variety of goals; the role of technology is to support the goals, not to determine them. Teachers and students have a range of choices in meeting production goals. Most important, production can facilitate the achievement of all students, regardless of language background, learning preference, or physical ability. Examples of both teacher and student products and the results of their creative processes are easily accessible on the World Wide Web. A review of some of these Web sites can inspire teachers and learners to integrate and use production tools in their teaching and learning and serve as models for product development.

Design appropriate assessments for technology-enhanced process and product.

Just as there is a huge range of production projects, there is a great variety of assessments that teachers and students can use to assess them. Most important is that both process and product are evaluated, and that students are involved in the assessments.

CHAPTER EXTENSIONS

To answer these questions online, go to the chapter 7 section of the Extensions module of this text's Companion Website (http://www.prenhall.com/egbert).

Adapt

Choose a lesson for your potential subject area and grade level from the technology-enhanced lesson plan archive at KidzOnline (http://www.kidzonline.org/LessonPlans/). Use the Lesson Analysis and Adaptation Worksheet (in the Teacher Toolbox) to consider the lesson in the context of production. Use your responses to the worksheet to suggest general changes to the lesson based on your current or future students and context.

Practice

Write objectives for a technology-enhanced project. Write specific content and language objectives. Share them with a peer and revise them as necessary. Use the "objectives" table from chapter 1 as needed.

Create student roles. Review the learning activity examples in this chapter. Choose three of the projects and suggest what roles you might create for students and who an authentic audience could be for each of the three projects.

Assess technology-enhanced learning. Choose one or more of the learning activity examples from the chapter and develop an assessment plan. Address who will be assessed, when, in what categories, based on what criteria. Also suggest how you would generate an overall assessment for the project.

Explore

Create a production handout for students. On paper, use graphics, text, and any other modes you can to outline for your students a production project that you might use in your class. Include information that explains to students the content and process of the task. Add a brief description of how the task process will be accessible to all students, regardless of language proficiency, content knowledge, or physical abilities.

Create a quick reference for production software or hardware. One way to learn a piece of software or a technology is to make a reference to help someone else. Choose a piece of software or hardware that you might use in the production process in your classroom. Explore your choice, examining the features and learning about the opportunities that it offers. Then create an explanation for students on how to use it. Be sure to make your reference appropriate for diverse learners.

Examine a production project. Choose a production project from a text, Web site, or other resource that is relevant to your current or future teaching context. Explain how the project you choose meets the guidelines and provides the opportunities mentioned throughout this chapter. Describe how it might be adapted to better meet the needs of all students and to use technology more effectively.

Create a production project. Review your content area standards and any other relevant standards. Choose a topic that works within these standards and other curricular requirements for your state or region and develop a technology-enhanced project around it.

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Thomas, J. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation.

# 10
# Chapter 8 Supporting Student e-learning

Although many states and organizations are developing standards for distance education, a widely accepted set does not yet exist. Rather, distance educators agree that e-learning should support content standards and state learning goals in the same ways that traditional classroom learning does. In addition, participating in distance learning can help students meet many standards, such as using technology tools to collaborate, communicate, solve problems, and inquire.

Specific guidelines for different types of online learning are being developed, but for now teachers can think about how e-learning might better help them meet curricular goals and student needs. If e-learning cannot meet these goals and needs, then a different instructional strategy should be used.

## OVERVIEW OF E-LEARNING IN K–12 CLASSROOMS

### What Is e-Learning?

Because learning through or with the aid of digital technologies like the Internet is a relatively new phenomenon that expands continuously, there are many terms to describe it and few consistent understandings of what these terms mean. For example, common terms to describe some or all aspects of learning through technology include distance education, distributed learning, open learning, online education, virtual classrooms, blended learning, and e-learning. Clearly, e-learning is not a learning goal per se but rather a structure or context for technology-supported learning through which content, communication, critical thinking, creativity, problem solving, and production can all take place. For this book, the term e-learning (short for electronic learning) means that the learning environment:

Is enhanced with digital technologies, particularly but not necessarily computer-mediated communication software (CMC, described in chapter 3)

Involves learning situations where interaction between the student and instructor is mediated, or bridged by technology, in some way

Uses technology in an ongoing and consistent way, not in isolated events

Is learner-centered

Focuses on students with instructor and student with student interaction

Uses a wide variety of resources

According to this definition, e-learning can occur in contexts such as

A face-to-face (f2f) classroom in an online chat

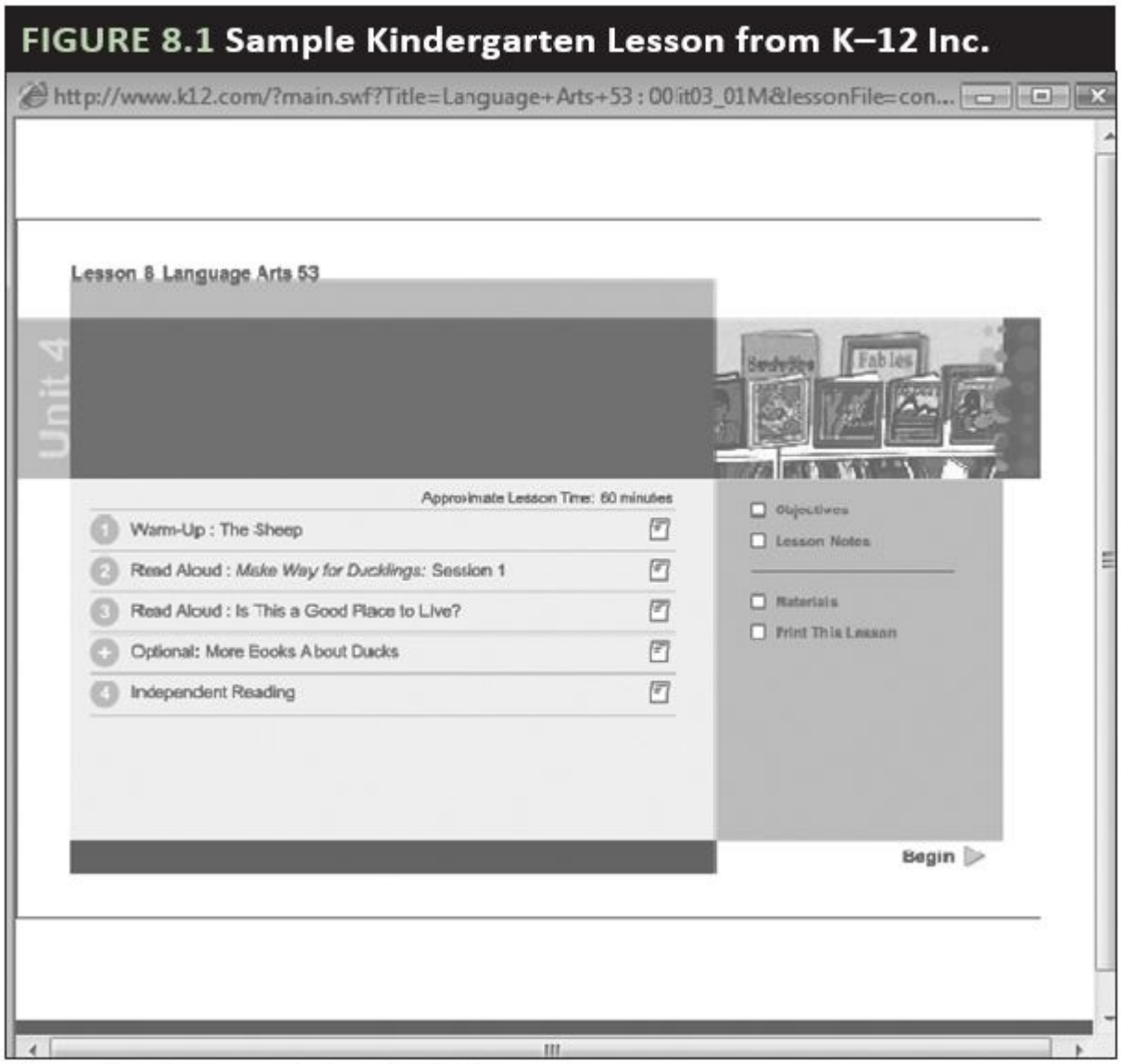
Video conferencing

A virtual school that is completely online (for examples, see the Idaho Virtual Academy, http://idva.k12.com/. A lesson provided by K–12, Inc. is shown in Figure 8.1; Florida Virtual School, www.flvs.net/)

Situations that combine these options (see the U.S. government's Star Schools at www.ed.gov/).

All of these examples fit the definition of e-learning in this chapter.

**FIGURE 8.1 Sample Kindergarten Lesson from K–12 Inc.**



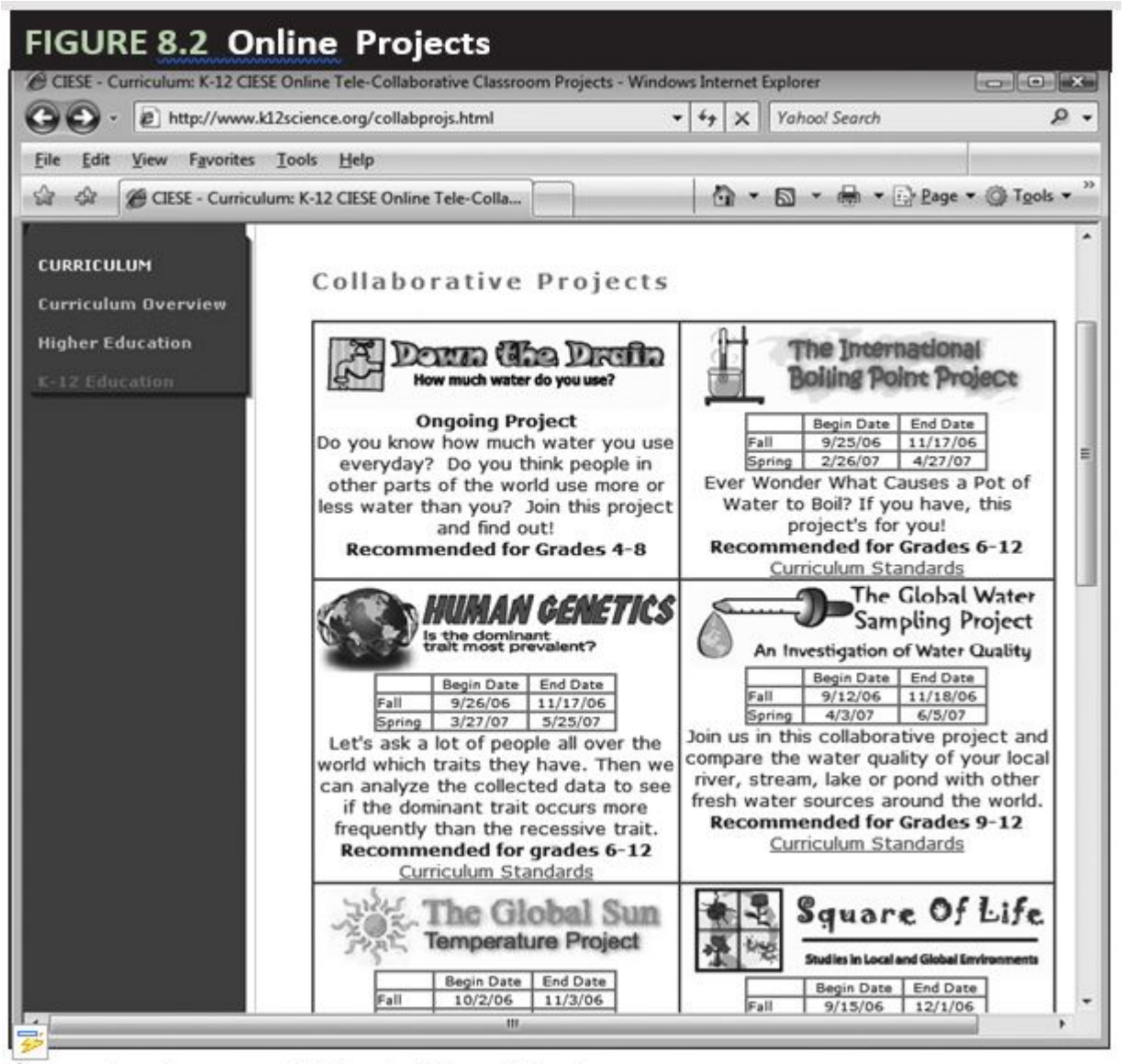

*Source:* Used with permission of K–12, Inc.

A combination of face-to-face and electronic learning can be referred to as blended, hybrid, or mixed-mode environments. Generally, in blended contexts, f2f time is partly given over to e-learning experiences. These optimal environments allow teachers to blend the best of f2f and online learning. Abate (2004) explains, "The traditional face-to-face elementary classroom imparts the social contact that children need to guide their learning while the online, or Web-based, learning environment offers flexibility and opportunities not possible in a traditional classroom. To create a learning environment using both modes to enhance the

learning experiences of the students would provide the greatest benefit" (p. 1). Giarla (2017) notes many benefits of blended learning, suggesting that blending f2f and e-learning can result in higher quality achievement and better teaching. Figure 8.2 presents online projects that could be integrated into a blended learning environment.

As in most instructional contexts, three general components interact to comprise e-learning:

Instructional and learning strategies, such as collaboration, reflection, problem-solving, communication




*Source:* http://stevens.edu/ciese/collabprojs.html

Pedagogical models or constructs, which indicate how learning takes place

Learning technologies, including everything from Web sites to communication software and digital cameras (Dabbagh & Bannan-Ritland, 2005)

However, there can also be crucial differences between traditional learning in f2f classrooms and e-learning; for example, Dabbagh and Bannan-Ritland (2005) contrast the characteristics of traditional and Web-based learning as outlined in Table 8.1.

| Traditional Learning Environments | Web-based Learning Environment |
|---|---|
| Bounded | Unbounded |
| Real time | Time shifts: asynchronous communications and accelerated cycles |
| Instructor controlled | Decentralized control |
| Linear | Hypermedia: multidimensional space, linked navigation, multimedia |
| Juried, edited sources | Unfiltered searchability |
| Stable information sources | Dynamic, real-time information |
| Familiar technology | Continuously evolving technology |

Note: Data from Why the Web? Linkages, by M. Chambers, 1997. Paper presented at The Potential of the Web, Institute for Distance Education, University of Maryland University College, Adelphi, MD. Source: Dabbagh & Bannan-Ritland (2005).

Who Are e-Learners?

Today, students of all kinds are participating in distance learning through a variety of e-learning opportunities. According to the U.S. Department of Education, in 2005, 36% of school districts and 9% of all public schools had 328,000 students enrolled in some kind of e-learning. High-poverty districts were among the most ardent supporters of using e-learning to provide services that the district could not otherwise afford to provide to students (Setzer & Greene, 2005). By 2009-10, 53% of districts had students in online courses, and 1.3 million high school students were enrolled (National Center for Education Statistics, https://nces.ed.gov/). Clearly, the trend is growing and has no indications of stopping soon.

Most K–12 elearners access their online courses from their schools, which often provide onsite help for e-learners. However, home learners, homebound learners, juvenile detainees, alternative school attendees, and school dropouts also use e-learning resources. E-learning is flexible enough to meet their needs for easy access and alternative curricula. Although the majority of e-learners who study completely online are in high schools, even younger children are taking part in e-learning tasks in their classrooms. Schools generally provide e-learning for advanced study and remediation, but many schools and districts are also making a systematic effort to use e-learning in reforming what they do across their classrooms. For example, second graders are communicating regularly through email with experts about class content, and ninth graders are working with students in other countries through the Internet to understand culture.

Because distance education at the K–12 level is still developing, the full results of these changes will not be available for some time. However, preliminary research shows that, done well, e-learning environments can be effective for K–12 learners (see, for example, Cavanaugh, Barbour, and Clark, 2009). Because e-learning concepts and understandings change rapidly and the research cannot keep up, Conceicao and Drummond (2005) suggest that the best place to find out about e-learning in K–12

contexts is to look at Web sites that provide examples of how e-learning is taking place.

## Contexts for e-learning

Many e-learning tasks and courses are interactive multimedia explorations among a variety of participants. However, some e-learning formats still replicate the isolating, one-way correspondence course. There is no one set format or way to conduct e-learning, but what it should not (and usually cannot) be is traditional teaching moved to a new medium. For example, in a text-based electronic forum, if the teacher monopolizes the discussion (the equivalent of offline lecture), it is easy enough for students to ignore her postings.

The use of technology for e-learning makes it imperative that teachers rethink how they teach and investigate what the new mediums afford. Such reassessment is necessary because during e-learning, communication can take place synchronously (at the same time) or asynchronously (at different times), and participants can be in a variety of spaces and places. The variety in these instructional features calls for a variety of approaches, as seen in the three scenarios that follow.

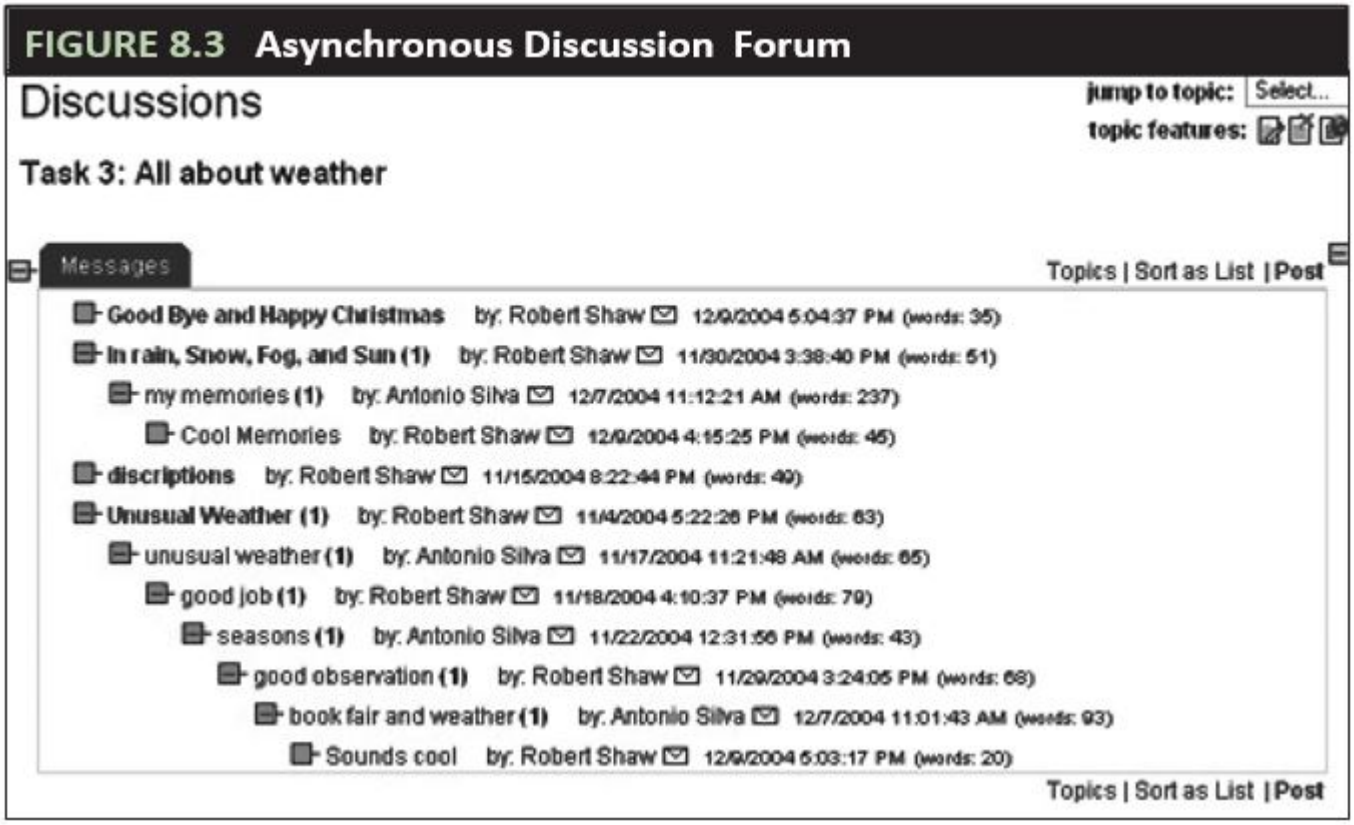
## Scenario One—Videoconferencing

The teacher and students at four different sites videoconference twice per week for an hour each session. Students find materials on the course Web site, use online chat to work in teams to collaborate on assignments, and receive help from teachers at their local school site when they have questions and concerns. They email or fax their assignments or post them to their Web site for evaluation, and they each have an office visit with the teacher by phone or Skype once per month.

## Scenario Two—Online Course

In a completely Web-based course, students who never meet their instructor f2f go into their course space in an online learning environment such as the free Canvas platform (https://canvas.instructure.com/) and find instructions for the current assignment. As they proceed through the assignment, they interact with other students and the teacher asynchronously through the discussion forum. They can ask for help and feedback, post comments and Web site URLs, and participate in an analysis of the topic at hand. They also send and receive emails with the teacher and consult the online resources available in the course space, including rubrics for the activities. After they turn in (fax, email, or post) the final draft of their assignments, they receive comments and a grade in a virtual space online that is only seen by them. Figure 8.3 shows the interface of one electronic forum where an ELL student and teacher are discussing weather as part of a unit on creativity. In the

threaded discussion shown, the comments are inset to show the order in which the comments were input and whether they are new messages or replies to a




previous message.

Scenario Three—Blended Learning

In an example of a hybrid or blended course, students in advanced high school science are released from two class periods each week to work on individual projects. They keep in touch with the other students and the teacher about their projects using an electronic forum where they post information about their progress.

……

As discussed in chapter 3, students could participate in other e-learning activities including communicating with external experts, accessing remote resources, mentoring and tutoring students at other sites, and working in projects where students collaborate with external peers or other audiences. There are many variations on e-learning, but all must comply with standards and guidelines for effective teaching. Fifteen years ago Blomeyer (2002) noted what is still true today; that the most important understanding that teachers and administrators must have about e-learning is:

In the final analysis, e-learning isn't about digital technologies any more than classroom teaching is about chalkboards. e-learning is about people and about using technology systems to support constructive social interactions, including human learning. (p. 5)

Characteristics of effective e-learning tasks

Small but critical differences exist between tasks in face-to-face classrooms and in online contexts. For example, Jackson (2004) contrasts content-high and process-high tasks that occur during e-learning. Content-high tasks, the most common in face-to-face instruction, are one-way resource dumps from instructor to student with little interaction. If this occurs during e-learning, students may drop the task or not do well because of the lack of support.

Process-high tasks, on the other hand, acknowledge the importance of interaction and communication among students and instructors before, during, and after the task. Employing process-high tasks is a principle emphasized throughout this text to support all learning goals and is especially important for online learning experiences (Tallent-Runnels et al., 2006). However, even process-high online activities lack the kind of student gestures, facial expressions, and other feedback that allow teachers to "read" how their students are doing. Teachers in f2f contexts find

this type of feedback essential during process-high tasks and must learn either to do without it or obtain it in another manner during online courses. To address this potential problem, effective e-learning tasks must have carefully designed opportunities for interaction. In addition, teachers can help students learn to convey their intentions through the use of text color and size (e.g., ALL CAPS MEANS SHOUTING), format (e.g., use italics for emphasis), and emoticons, or text-based emotion icons (find a complete definition and a list of emoticons at the What is . . . site at http://whatis.techtarget.com/).

In addition, effective e-learning tasks employ multimedia rather than one medium. If the interaction during e-learning is solely in writing it can pose a barrier to language learners and other students with different reading and writing abilities. To overcome this barrier, accompany instructions sent in an email message with a recording of the message and/or attach a handout with graphics.

To be effective, tasks must also be diverse and have clear instructions so that students are not bored or confused before they begin. To avoid confusion, effective e-learning tasks should include ways for students to:

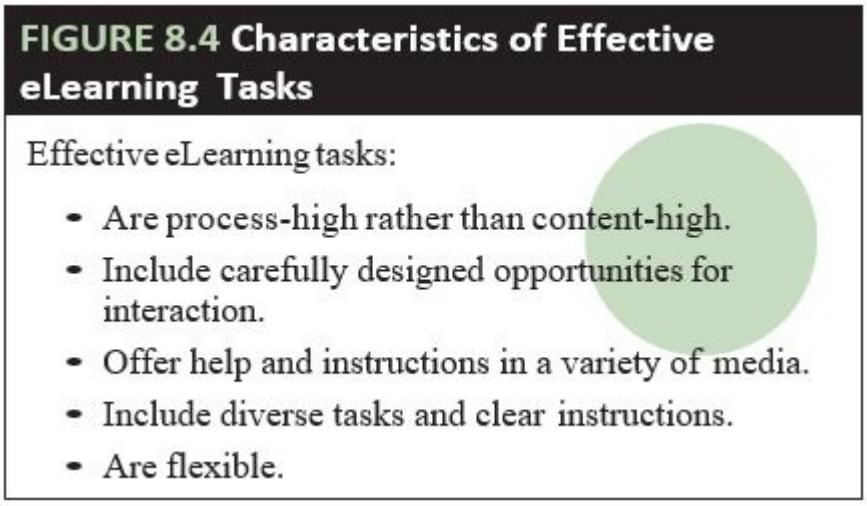
Receive reinforcement.

Review or repeat any part of the task.

Ask for help or remediation for parts of the task that are not clear or are too challenging.

This is relatively easier to do in blended contexts because the teacher can interact f2f with students and understand their needs more readily.

Finally, because students typically work more independently when involved in e-learning tasks, extra time may be needed to complete tasks. Therefore, build flexibility into the assignment ahead of time. Characteristics of effective e-learning tasks are summarized in Figure 8.4.




Student benefits from e-learning

Students can derive a number of benefits from participating in effective e-learning tasks. A Teacher's Guide to Distance Learning, published online by the Florida Center for Instructional Technology (http://fcit.coedu.usf.edu/distance), suggests that e-learning can have the following benefits for students:

Flexibility/control. When students participate in true e-learning, they have more control over their learning. They can choose the pace, site, and format of their learning. Students in many e-learning situations can also choose what they wear to learn.

Responsibility. During e-learning, students are required to become active, responsible learners. To be successful, students must develop skills in working independently, in asking for help, and in interacting with fewer nonverbal cues from other participants.

Exposure. Often, e-learning exposes students to resources, people, and interactions that may not occur in traditional f2f tasks or environments. This idea was outlined in chapter 3 and throughout this book.

Interaction. During e-learning, students learn technology and have more opportunities to interact with teachers than in traditional classrooms. Shy students, those with limited language skills, and those with physical limitations can often have more time and more access to the interactions because they can read and respond at their own pace.

Anonymity/equity. When students are online, cultural, physical, and other personal attributes are not focal and are often invisible during interaction. The online format can be more equitable for students

with noticeable speaking differences, physical disabilities, and other characteristics that might present barriers in f2f interactions.

Convenience. E-learning opportunities come in all shapes and sizes. While some require attendance or a starting date at specific times, others allow teachers and students to set their own schedules.

Overall, research shows no significant difference in student achievement between good f2f instruction and e-learning. In other words, if done well, both can work toward student achievement. However, in a way the comparison is a false one—students do different kinds of tasks during e-learning and they learn in different ways, and therefore it is important to offer a variety of options for learning, including face-to-face time. Researchers are looking into these outcomes more closely to see which factors promote what kind of achievement for which students. For example, according to an analysis of the research on distance learning, the 2016 National Education Technology Plan (https://tech.ed.gov/netp/learning/) concluded that:

Historically, a learner's educational opportunities have been limited by the resources found within the walls of a school. Technology-enabled learning allows learners to tap resources and expertise anywhere in the world, starting with their own communities.

School and district e-learning benefits

In addition to student benefits, e-learning also has benefits for teachers, schools, and districts. According to the National Education Technology Plan (essential reading for any teacher; Office of Educational Technology, 2016),

Educators can design highly engaging and relevant learning experiences through technology. Educators have nearly limitless opportunities to select and apply technology in ways that connect with the interests of their students and achieve their learning goals. For example, a classroom teacher beginning a new unit on fractions might choose to have his students play a learning game such as Factor Samurai, Wuzzit Trouble, or Sushi Monster as a way to introduce the concept. Later, the teacher might direct students to practice the concept by using manipulatives so they can start to develop some grounded ideas about equivalence. (n.p.)

These are benefits that cannot be overlooked in this age of shrinking funding, teacher shortages, and increased accountability. Of course, there are also disadvantages to e-learning.

Disadvantages of e-learning

The disadvantages of e-learning, like the benefits, vary by context. These include, for example:

Teachers might find it difficult to meet all learners' needs in a completely online course since some need more structure or f2f interaction than exists in e-learning contexts.

Learners at a distance from the teacher might not have support for technical problems.

Students who do not have access to technology outside of school may not have the option to participate.

Teamwork is more complicated in online contexts because the typical classroom immediacy of contact is mediated by access to and use of the technology.

If information and resources are not carefully chosen, the learner can be overwhelmed with the amount of information available online.

The often-huge number of discussion postings and assignments for teachers to check in completely online classes might prevent students from getting the direct, immediate feedback that they need.

In spite of these difficulties, adding e-learning to f2f courses, such as integrating a discussion board or class blog, for example, can enhance effective learning. In addition, the "broader educational community" can contribute to the experiences.

**FIGURE 8.5 Benefits and Disadvantages of eLearning**

| Benefits | Disadvantages |
|---|---|
| Provides students with flexibility/control | Might be harder for teachers to meet student needs at a distance. |
| Builds responsibility | Technology glitches must be solved by students. |
| Exposes students to new resources, people, and interactions | Some students do not have access outside of school. |
| Provides equity through anonymity | Teamwork is more complicated online. |
| Is convenient | Students may have to wait for feedback. |
| Cost savings, efficiency, and improved accessibility in schools and districts | The amount of written data can be overwhelming for students. |
| Engages students | The amount of written work to evaluate and respond to may be overwhelming for teachers. |

## E-LEARNING PROCESSES

The benefits from e-learning will accrue if participants pay careful attention to the processes involved. These include:

The teacher's (or instructional designer's) process of creating e-learning opportunities

The student's process in taking those opportunities

According to Bowman, teachers and instructional designers generally use the following process to create and implement successful e-learning experiences:

Plan—assess the learners and the technology.

Design—develop learning objectives that advance content to [achieve] desired learning outcomes.

Develop—match learning objectives to media using multiple strategies to engage creativity (e.g., lecture, text, audio, video, case study, team projects, practical exercises and individual assignments, interactive problem solving, student-to-student interaction).

Implement and evaluate—use iterative (repeating) design so activities can be improved and updated easily. (n.p.)

During e-learning tasks, students must:

Understand the assignment.

Learn the technology to a level sufficient to complete the task(s).

Interact with the online community to build understandings.

Complete the assignments and related assessments.

Depending on the goals of the e-learning course, students will also use processes to solve problems, communicate, produce, and meet other learning goals.

### Teachers and e-learning

Teachers must often learn new skills and take on new responsibilities in e-learning environments. Ko and Rossen (2017) note that online instructors, while sharing the need for good communication and organization skills with f2f teachers, also require a different set of skills. These include:

Planning for asynchronous or other distant interaction

Organizing detailed tasks and instructions

Using presentation skills specific to e-learning environments

Using questioning strategies for different (often unseen) students

Involving students across different sites

Using student progress reports and learning analytics

Connections to social media

Keeping updated on the technologies

These needs might require that the instructor learn new technologies and teaching strategies, as described in the following section.

The teacher's role

There are cases where electronic instruction consists of lectures posted online, but these are not good examples of e-learning. The teacher's role in e-learning is to be a facilitator, making sure that students are engaged in working toward learning goals. In this role, teachers can:

Build rapport with students by meeting with them f2f or working on a personal basis at the start.

Encourage e-learners by addressing feedback to them by name, and guide them in finding their own answers.

Make sure students are spending their time effectively, not spending a disproportionate amount of time on assignments but working efficiently toward the course or task objectives.

Divide classes into discussion groups. More than six members in a group tends to isolate at least one member. Fewer tends to shut down the group in the event two members become unavailable (Jackson, 2004).

Require individuals to identify their discussion posts clearly. Also require groups to summarize their group discussions so that students do not need to read every posting.

Create a presence in the course or task. Let students know that the teacher is observing and is available.

Above all, teachers must be able to promote successful interaction during e-learning.

### Challenges for teachers in creating e-learning opportunities

There are barriers that teachers may face when first using e-learning. For example, the technology chosen for the course can get in the way of instruction because it mediates in ways that prevent teachers from receiving and providing visual cues or instant feedback. Therefore, teachers and course designers must make instruction direct and concise. They must also take into consideration:

The difficulty for students of reading extensive text on a monitor

The time it takes students to type their responses

The pace and amount of information such as video clips, discussion postings, and Web- based data

To work around these challenges, during course design teachers can work with an instructional designer, a technology specialist, the library media specialist, and even students. Once the course or task is designed, teachers can and should partner with the students' on-site teachers and counselors. To see an example of teachers partnering with others, take the online tour of Virtual High School at www.govhs.org/website.nsf.

## GUIDELINES FOR SUPPORTING STUDENT E-LEARNING

This chapter has shown that e-learning is not entirely different from f2f learning, nor does it require completely different teaching skills. Likewise, the guidelines in this section apply to all learning contexts, but they take on importance in e-learning contexts, whether hybrid or fully online.

### Guidelines for Designing e-learning Opportunities

Four guidelines for building effective, interactive e-learning opportunities are presented here.

Guideline #1: Build community. Whether participating in a Web-based course or a technology-enhanced homework assignment, students need to know that they are not alone and that others are working toward the same goals. It is important that students identify themselves as members of the learning community whether they are face-to-face with other students or in a virtual on- line classroom. Strategies for building community include encouraging all students to participate, providing support for group work, connecting learning to students' lives as a group, and incorporating team-building exercises into tasks. Community can also be built using strategies such as all participants using others' names when they are interacting online, posting profiles (and possibly photos) that help learners choose group members and get to know more about each other, and having online chats to give learners a

chance to work together in real time.

Guideline #2: Consider the hidden curriculum. In any curriculum, there are elements that are not explicitly taught (i.e., they are “hidden”). These include values, relationships, societal

norms, and expectations. These are essential elements that students are expected to learn. E-learning also has its hidden curriculum, such as the cultural and social impacts of e-learning. Questions for teachers to answer that address this hidden curriculum include:

Who benefits from the way information is being presented?

What dominant ideology, explicit or implicit, is being espoused?

What is credit being given for in the course? Participation? Writing well? Citing the course texts?

What kind of student will succeed or fail in this context?

How is technology valued?

Who should be allowed to participate in this e-learning experience?

This last question arises from the economic impact of courses that are offered for a fee.

Guideline #3: Organize ahead of time. A Web site or learning management system (LMS) like Canvas or pbworks that accompanies e-learning opportunities and provides the following can help students and teachers work more efficiently and effectively. This site should include:

One-stop location for up-to-the-minute course announcements, materials, assignments, etc. Digitized information is also easily modified and maintained.

Resource and access capabilities for all students.

A way to display and receive resources which may otherwise be difficult to assemble or locate, such as samples of assignments (good and bad with reasons why), or hot links to Web sites used for course assignments (for example, analyses of corporate annual reports).

Online archive of course slides, graphics, digitized video, for student retrieval and study on their own time.

Digitized multimedia that illustrate course concepts, especially those that are interactive. (n.p.)

By organizing ahead of time and creating a Web site with all the essential information and tools, teachers will have more time to dedicate to the important interactions necessary to the success of e-learning.

Guideline #4: Give clear instructions. Part of organizing e-learning is clarifying what students need to do and how they should do it. Because students are generally not in the same room as the teacher and typically cannot ask questions on the spot, the instructions for e-learning tasks need to be very explicit and models, if available, should be accessible to students. This seems easier than it really is—classroom teachers usually rely on being able to "read" their students to clarify and add to instructions, and it takes practice to write good instructions that do not need further explanation. Figure 8.6 summarizes the guidelines for e-learning.

**FIGURE 8.6 Guidelines for eLearning**

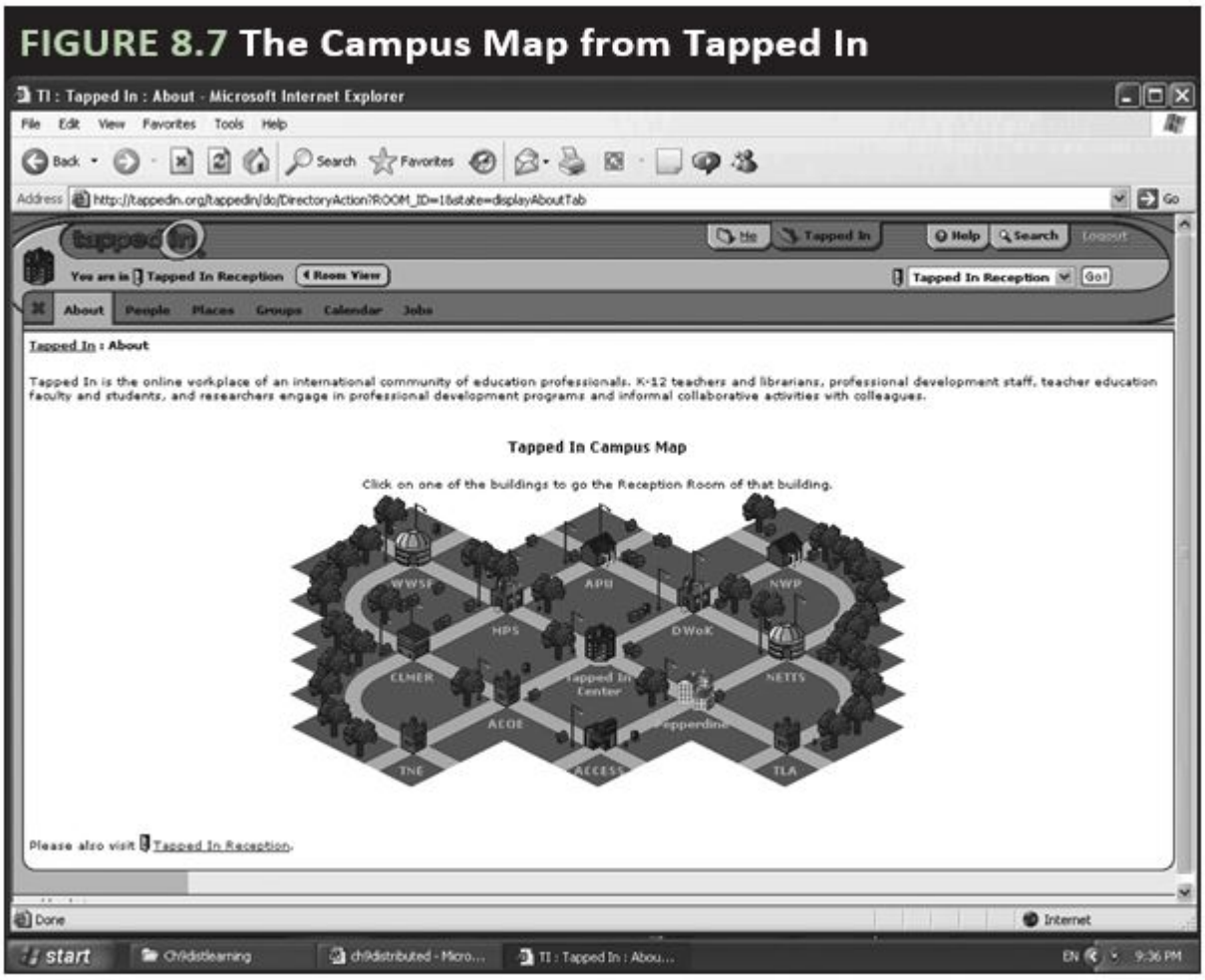
| | |
|---|---|
| Guideline #1: Build community. | Help students find common interests and goals and interact in productive ways. |
| Guideline #2: Consider hidden curriculum. | Reflect on the impacts of what is taught and how. |
| Guideline #3: Organize ahead of time. | Lay out the documents and information that students will need. |
| Guideline #4: Give clear instructions. | Put everything in writing and/or graphics that you might say or show to embellish the same instructions in a f2f context. |

## E-LEARNING TOOLS

Because e-learning occurs in so many configurations and contexts, many different tools, alone or in combination, are used. Electronic tools for e-learning can include any of the tools mentioned throughout this text (CD-ROMs, videos, social media, and so on). From printed materials such as textbooks and handouts to simple audio material such as audiocassettes to the latest computer technologies, almost any tool can be integrated into e-learning. However, most formal e-learning contexts currently include interactive technologies such as the World Wide Web, email, and video technologies. It is not within the scope of this text to discuss how to use all the tools that are used for e-learning, but the annotated collection presented in this section can help teachers begin an investigation of common e-learning tools. Most of the tool Web sites include tutorials and other support for new users.

In addition to an Internet connection, a Web browser (e.g., Google, Internet Explorer, Firefox, Safari) with add-ons (i.e., mini-applications or plug-ins) will help students listen to audio, see video, and compose and send email. Other tools that can be used during hybrid and on-line classes include the following.

**FIGURE 8.7 The Campus Map from Tapped In**




*Source:* Copyright SRI International. Tapped In is a registered trademark of SRI International.

Learning environments

Learning environments provide online or “virtual” places to interact and post course content. Some environments are commercially produced, others are free. Some are authorable, or able to be changed by users, while others cannot be changed. Many commercial environments come with preset content; others allow the use of homegrown (locally produced) content. Each tool has specific strengths and weaknesses that can best be found by using it in context (most offer a demonstration version and technical assistance for evaluation purposes).

Some popular learning environments are listed here. They typically include some preset features such as asynchronous threaded discussion, internal email, document and link posting, and synchronous chat capabilities. For less structured environments, see authorable platforms later in this section.

Commercial environments

Blackboard (www.blackboard.com)

Canvas (canvas.instructure.com/login/canvas; free for teachers)

Nicenet (www.nicenet.org; free for teachers)

Wikis, blogs and other free virtual spaces

Wikis, blogs (web logs), vlogs (video logs) and other spaces like those provided by Facebook, Twitter, and other social media forums can also function as learning environments where students can go to practice what they learned face to face, interact with other students in different locations, or hold class meetings.

For a list of education-based wikis, try the Teaching with Thinking and Technology at https://teaching-with-technology.wikispaces.com/Wikis+in+Education

Free blogs for students can be found at edublogs (edublogs.org), kidblog (kidblog.org), and 21Classes (www.21classes.com). All of these blogs are evaluated on the Web for use in classrooms, and teachers are well-advised to check some of the advice that other teachers provide.

Students and teachers can both watch vlogs and create their own. Search “vlogs for students” or “vlogs for education” to get started.

Web page/ Web site creators

Weebly and Wix (mentioned throughout this text) and many other free web site creators are available across the Web. Unlike in the past when students had to learn to use HTML to build their site, these apps allow students to click and drag and make professional-looking pages. Each has its own strengths and weaknesses, and teachers should try the ones they are interested in before having their students use them. Crockett (2016) provides a succinct list of useful educational web site creators at https://globaldigitalcitizen.org/8-free-website-creator-tools.

Web page hosts

All of the following Web sites host personal Web space for free, although some do require registration. Instructors and students in e-learning courses can create Web pages to share their ideas and work, whether they are in different locations or in the same classroom. There are many more providers across the Web than are listed here.

Quia (www.quia.com/)

FreeSite.com (www.thefreesite.com/Free_Web_Space/)

Bravenet.com (www.bravenet.com)

Blogger (www.blogger.com)

TeacherWeb (http://teacherweb.com)

SchoolNotes (www.schoolnotes.com/)

Tripod (www.tripod.lycos.com)

Quiz and assessment tools

A large number of quiz and survey tools are available to conduct pre- and post-assessments with students both online and off. For example:

Quizstar and Rubistar (www.4teachers.org). Create quizzes and rubrics easily with these free tools.

Survey Monkey (surveymonkey.com), Doodle (doodle.com) and other free software apps can be published to the Web for all kinds of data-gathering purposes.

Video and audio conferencing tools and resources

Not typically as comprehensive as learning environments, conferencing tools allow students to meet and discuss as part of hybrid and completely online classes. For example, third graders learning about space can call a scientist at NASA for free, or middle school students in an online course can hold a videoconference with peers in Germany to compare ideas about important world problems. Usually these resources provide some combination of video, audio, and/or text capabilities, and many are free. Telephony software, or software that allows the user to make telephone calls over the Internet, is currently very popular. Examples of free conferencing and telephony software include:

MSN Messenger with Video and/or Voice (imagine-msn.com)

Yahoo Messenger (http://messenger.yahoo.com)

iChat (www.apple.com)

Skype (www.skype.com)

To learn about the benefits of videoconferencing, see https://www.eztalks.com/video-conference/benefits-of-video-conferencing-in-education.html.

Digital libraries

Students and teachers can take advantage of digital libraries in hybrid and online courses. These libraries contain everything from raw data to online texts. Examples include:

Library of Congress (https://catalog.loc.gov/)

NASA Astrophysics Data System (http://adswww.harvard.edu/)

Project Gutenberg (www.gutenberg.org/)

Visible Human Project (www.nlm.nih.gov/research/visible/visible_human.html)

Find more resources for both teacher and student use in the Teacher Toolbox that accompanies this text.

Content-based learning sites

Content-based Web sites, along with content-based stand-alone software packages, are mentioned throughout this text and can be integrated into both hybrid and online classes at all grade levels. Here are some useful sites:

National Geographic Kids' Network (http://kids.nationalgeographic.com/)

i*earn Learning Circles (www.iearn.org/circles/lcguide/)

PBS Kids (pbskids.org)

Discovery Channel (www.discoveryeducation.com/)

Library of Congress learning page (http://lcweb2.loc.gov/ammem/ndlpedu/)

Software archives

These online storage places for software offer free or very cheap downloads for education software that can be integrated into e-learning contexts. Not all of it is the best, and teachers need to review their selections carefully.

Tucows (www.tucows.com)

WinSite (www.winsite.com)

download.com (home and education; http://download.cnet.com/s/home-and-education/?cat=education)

One of the best sources on the Internet for online learning resources is e-Learning Centre's School e-Learning Showcase at www.e-learningcentre.co.uk/resources. Figure 8.9 summarizes some of the tools available for e-learning. Other tools are gaining popularity as e-learning flourishes.

**FIGURE 8.9 eLearning Tools**

| Tool | Examples |
|---|---|
| Learning environments | MOOs, commercial environments, authorable platforms |
| Quiz and assessment tools | Surveys, rubric makers, quiz makers |
| Video and audio | Conferencing and telephony software |
| Digital libraries | Video and text compilations |
| Content-based learning resources | Lesson archives, activity sites, resource pages, software packages |
| Software archives | Shareware and freeware |

LEARNING ACTIVITIES: e-learning

As noted throughout this book, it is not the tool that makes the difference, but how it is used. This is also true for e-learning. Throughout this text, e-learning activities such as epals, virtual field trips, ask the expert, and technology-supported communications have already been mentioned. Like other parts of this chapter, this section looks at the differences between hypothetical face-to-face (f2f) contexts and e-learning opportunities. It describes what an instructional feature or task might look like as part of an e-learning context. The features and tasks described here could be part of a hybrid or an online course. The colored text signals adaptations for e-learning.

Feature: Instructions

F2f: The teacher says, “Do exercise 5 on page 6. Ask me if you have any questions.”

e-learning: Written instructions say,

Step 1. Read the instructions for exercise 5 on page 6.

Step 2. Answer the question in no more than a paragraph using complete sentences.

Step 3. Post your answer in the Unit 1 discussion thread in the class discussion forum.

If you have questions, email your online buddy for help. This assignment is due by 3 pm on Thursday.

For e-learning, the instructions must not only be more precise, but in writing them the teacher must also try to predict what questions students might ask.

Feature: Lesson presentation

F2f: The teacher gives a lecture about creating how-to (process) essays and points out the important features.

e-learning: The instructor has students read examples from the course Web site and How Stuff Works (www.howstuffworks.com). Students then go to the online forum and discuss the important characteristics they see in process essays. Together they create a features checklist for process essays they will write.

In the online environment, this task becomes much more learner-centered.

Feature: Lesson presentation

F2f: The teacher leads a discussion based on drawings of how the Internet works from the textbook’s technology section.

e-learning: Students work in teams to complete one or more of the Peter Packet missions in Cisco’s Packetville at www.cisco.com/. (See Figure 8.10 for the introduction screen.) Using external documents such as questionnaires and graphic organizers posted to their course site by the teacher, students record important information as they discover it. They post their findings to the discussion area of the course site for other students to review.

The addition of online resources not only pushes students to be more independent learners but also addresses the needs of students with different learning preferences.


*Source:* These materials have been reproduced by Prentice Hall Inc. with the permission of Cisco Systems, Inc. Copyright © 2005 Cisco Systems, Inc. All rights reserved.

Task: Propose solutions for how to end world poverty

F2f: Students read texts about world poverty and discuss solutions with classmates.

e-learning: Through the United Nation's Millenium Development site (www.un.org/), students work with information and people from all over the world to investigate, understand,

and work toward solutions for world poverty.

With e-learning integrated into the course, students can receive information directly from those involved in the issue, which broadens not only their audience but also their potential understanding.

Task: Prepare to study sharks

F2f: Teacher asks students to look at pictures of sharks in their text and brainstorm a list of what they understand about sharks from the photos.

e-learning: Students watch the shark videos from Nova Online at www.pbs.org/ and brainstorm a list of what they understand about sharks from the videos.

The online videos provide a more authentic glimpse of sharks and allow students to produce more language and content than the still photos from the book.

Students can learn without participating in e-learning. However, it is clear from these simple examples that, although e-learning might require more advanced planning and reassessment of important teaching skills, electronic resources and technologies can help teachers to change, in powerful ways, the focus of learning from teachers to students.

## ASSESSING E-LEARNING

E-learning requires different options for assessment because, particularly in Web-based courses, the instructor cannot always observe students. Tests, quizzes, surveys, and other standard evaluations can be constructed and implemented with the tools noted above and in other chapters. However, as in traditional classrooms, these assessment tools do not provide the whole picture of student progress and achievement. Portfolios are one solution to this problem.

### Overview of Portfolios

A portfolio is a purposeful, reflective collection of student work. Purposeful means that it is not a folder that contains everything students have done, but rather it is a focused compilation of student work that is developed with guidelines from both the teacher and the student. Traditional portfolios help students set learning goals, encourage students to reflect on their growth and achievement, serve as a basis for communication with parents and other stakeholders, and allow teachers to see how students are performing and plan to address gaps. There are many types of portfolios. Two common types are:

Showcase—Students display only their best work.

Developmental—Students show their progress over time.

In each case, the binding element is student reflection. Many excellent texts describe the use of

portfolios to assess student progress and achievement.

e-portfolios

E-portfolios are portfolios that are kept in an electronic format (video, audio, computer-based). There are many reasons to use e-portfolios. In addition to the benefits mentioned above, e-portfolios are easy to store and access. They require students to develop multimedia skills that support the NETS standards. In addition, they can include sound, video, graphics, and photos, animation, and more, allowing students to demonstrate their learning in multiple ways.

The steps for developing e-portfolios are the same as for paper-based portfolios, except that e-portfolios require a technological aspect. The general steps that teachers and students can take are outlined below (adapted from Barrett, 2000a, 2000b; Chamberlain, 2001; Niguidula, 2002):

Identify the purpose of the portfolio. Is it to showcase students' outstanding work, to show progress, to share with stakeholders, to demonstrate mastery, or something else?

Identify the desired learner outcomes. These should be based on national, state, or local standards and curricular requirements and include learner goals.

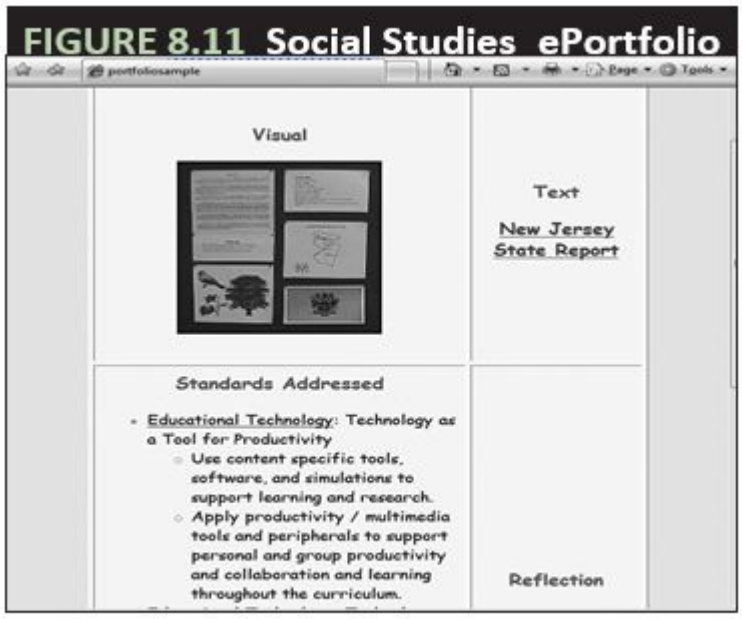
Identify the hardware and software resources available and the technology skills of the students and teachers. Barrett (2005) provides examples of commercial portfolio software and other tools such as PowerPoint (Microsoft) that can be used in e-portfolio development.

Identify the primary audience for the portfolio. The audience could include a college registrar, a future employer, a parent, or peers, for example. Choose a format—Web-based, CD-ROM, video—that the audience will most likely have access to. Chamberlain (2001) notes that teachers are required to obtain permission from students' legal guardians before posting student work online. She provides sample permission letters at www.electricteacher.com.

Determine content. Teachers and students can develop a checklist of required content, including the sequencing of the information.

Gather, organize, and format the materials. Students should be required to include reflections on each piece and on the entire portfolio. Figure 8.11 shows a page from a sixth-grade social studies e-portfolio.

Evaluate and update as necessary. Web creators and even Microsoft Word can be used to provide templates for students to enter work samples




*Source:* Used with permission of Maunawili Elementary, Kailua, Hawaii.

and other relevant material.

E-portfolios can be evaluated by rubrics that assess each step of the process (see chapter 3 for a discussion of rubrics) and that focus on meeting the standards or on other qualities deemed important, such as collaboration and participation. Other examples using a variety of tools can be found in the electronic portfolio samples section of www.forsyth.k12.ga.us/ and http://dragonnet.hkis.edu.hk/ http://wp.auburn.edu/writing/eportfolio-project/eportfolio-examples/.

## Conclusion

In 2001, Bailey summed up the focus and importance of e-learning; his ideas are still pertinent:

We need to move beyond the notion that education is about school buildings, school days, and classrooms. For us to move forward with not just e-learning, but learning in general, we must accept the reality that education can now be delivered to students wherever they are located.

Schools need to become education centers. With distance education, schools become access points to a whole range of educational opportunities. Until schools recognize that their mission is fundamentally changing as a result of e-learning, we're only going to make incremental progress toward this important objective.

Every educational program is a technology opportunity and every technology program is an educational opportunity. While our investment in technology does help schools purchase computers and networks, it is also fundamentally about purchasing math courses and additional online resources and distance

education classes for their students. It isn't about the boxes and the wires. It is about teaching and learning. It is the instructional content and its applications that should drive technology, not the other way around.

Online assessment, particularly online assessment with e-learning technologies, is one of the next generation "killer applications" that is waiting for us out there. When online assessment results are tied into e-learning systems, the potential benefits become very significant. The result should be more effective use of class time and a system of education that isn't based on mass production, but is instead based on mass customization.

Finally, together as industry and as government, we need to be relentless in measuring and assessing the impact that technology has on education and on academic achievement. We need evidence that teaching and learning are improved as the result of technology. Using technology to teach using traditional methods will only lead to traditional results.

As better, faster, cheaper, and more accessible technologies are developed and classrooms move more toward online learning, these issues will be crucial to understand and implement. However, we must also remember the face-to-face interactions that students need and value.

## FROM THE CLASSROOM

### e-learning

Technology and machines have become such an integral part of our lives. There are certainly consequences—both good and bad—that are a result of this. You are probably all familiar with the many online educational classrooms/schools there are now. It just fascinates me when I go to some of their Web sites and browse through what a typical "school day" is for elementary and high school students who stay at home and learn via the computer/online courses. I think a balance is best. I can't imagine how those student graduates of Internet schools negotiate people and peer skills. (Jennie, first-grade teacher).

It's easier to see another angle or point of view when you don't have those emotional cues in your face! (April, middle school teacher).

## CHAPTER REVIEW

Key Points

Explain e-learning and how it can help meet learning goals.

E-learning consists of three basic components: (1) instructional and learning strategies,

(2) pedagogical models or constructs, and (3) learning technologies. e-learning contexts range from hybrid classes to those completely online and at a distance from the teacher. e-learning can help schools meet the needs of a variety of students.

Discuss guidelines for creating e-learning opportunities.

Although guidelines and tips for e-learning can also apply to f2f classrooms, they are especially crucial to follow in e-learning contexts. Teachers must work toward building a community of learners and consider what the hidden curriculum means for the students in the class. To facilitate online learning, teachers can organize ahead of time and work toward giving clear instructions.

Describe e-learning tools.

Almost any electronic tool, and many other types of tools, can be and are used as part of e-learning. The tools must, however, support and enhance student learning and not impede it.

Develop and evaluate effective technology-enhanced e-learning activities.

Features of effective e-learning activities are much the same as for those in f2f contexts, but with the added elements of technology and differences in how time is used. Activities that follow guidelines for good teaching will be effective both online and off, as long as the medium in which they are employed is considered.

Create appropriate assessments for technology-enhanced e-learning activities.

Although this book outlines many kinds of assessment that are available for e-learning, e-portfolios have many benefits for teachers, students, and other educational stakeholders.

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III

# PART III

# 11
# PART III Supporting Teachers

# 12
# Chapter 9 Supporting Teacher Development

The International Society for Technology in Education (ISTE), in addition to developing the widely used national education technology standards for students (NETS*S), has also developed a set of standards for teachers, called NETS*T, which focus on pre-service teacher education (available at https://www.iste.org/standards/standards/for-educators), and they also provide guidelines for teachers who are still learning about technology. The NETS*T recommend that teachers function as learners, leaders, citizens, collaborators, designers, facilitators, and analysts as they support the student standards in their classrooms. Part of what these standards require is that teachers understand and can use technology to work toward student creativity, production, critical thinking, and other learning goals. In other words, teachers are charged with not only learning the technical aspects of technology, but also practicing how to meet learning goals and discovering the technology that allows and enhances such opportunities. Rubrics, lessons, and other resources that can help teachers to measure and use the standards can be found at http://www.iste.org/standards/standards. It should be noted that, although many states and districts use the ISTE standards, they are themselves not law. However, there is a federal requirement, presented in the reauthorized Elementary and Secondary Education Act (2015), for states to meet these goals:

Improving student academic achievement through the use of technology

Assisting students in becoming technologically literate by the time they finish eighth grade

Ensuring that teachers can integrate technology into the curriculum.

In whatever way states choose to make sure these goals are met, whether by adopting the NETS*T or developing their own standards, teachers no longer have a choice about using technology in their instruction. How well they do so may depend on large part on the effectiveness of their professional development experiences in technology-supported learning.

## OVERVIEW OF PROFESSIONAL DEVELOPMENT IN TECHNOLOGY-SUPPORTED LEARNING

### What Is Professional Development?

Professional development (PD) is an opportunity that leads to an increase or change in skills, knowledge, abilities, and understandings. These changes can occur through any number of means. PD experiences include individual study, action research, in-service workshops, online graduate courses, internships, temporary residencies in organizations, curriculum writing, peer collaboration, school or district study groups, peer coaching or mentoring, or work with a mentor or master. Most states or districts require teachers to participate in specific amounts of some kind of PD to keep their teaching certification current or to meet the requirements of their Professional Improvement Plans, and it's a good idea for pre-service teachers to keep this in mind as they plan their first years of teaching. However, the outcomes of PD typically are not measured in any substantive way, the thought being that any PD is effective in helping teachers to teach well.

Unfortunately, not all PD opportunities are the same, and certainly not all are useful. While investing in staff development and supporting good teaching are the best ways for schools to make sure that technology use leads to student achievement, PD experiences cannot simply consist of learning new techniques to apply "tomorrow." Rather, PD must help teachers to "transform their role" by understanding current educational issues, implementing innovations, and improving their overall practice (Wood, Goonight, Bethune, et al, 2016). In other words, the purpose of PD is not for teachers to teach better in traditional ways, but to learn better and different ways to teach. Both incremental and fundamental changes are important to the change process. However, teacher changes and related changes to the education system are complex and dynamic and cannot happen through short-term, one-shot opportunities for professional development.

Teacher Uses of Technology

**FIGURE 9.1 Teacher Uses of Technology**

| Use | Purpose | Examples |
|---|---|---|
| *Personal* | Highly relevant uses that help them in their daily lives | Use email to keep in contact with family members; write letters and other documents. |
| *Administrative* | Make their school lives more efficient | Send and receive emails about meetings and announcements; create worksheets and other handouts; post word processed documents; record attendance and assessments; grading and seating charts. |
| *Academic* | Directly support classroom learning goals | Help students find resources and perform procedures such as typing essays; encourage students to produce, solve problems, communicate, think critically and creatively, explore and learn content more deeply. |

Key to understanding the issues of professional development in technology-supported learning is understanding teachers' uses of and attitudes toward technology. In general, there are three categories into which teacher technology use falls: personal, administrative/productivity, and academic. Figure 9.1 outlines these three uses.

All of these technology uses are important in the development of competent technology- using teachers. Most important for professional development is that teachers see that PD is linked to their immediate needs and interests.

The Need for Professional Development Opportunities in Technology

After a single pre-service teacher education technology course, many practicing teachers discover that they are unprepared for the realities of teaching and using technology to transform their classrooms and schools. In addition, few teachers emerge from their teacher education programs equally competent in each of the three categories of technology use mentioned previously. Although teachers often seek out and take advantage of chances to learn about technology for personal and administrative uses, typically fewer informal opportunities to learn about academic uses are available.

New learning standards in all areas and the need to develop better ways to assess students are pushing teachers to change their roles in classrooms and schools. Many teachers feel the stress of trying to keep up with academic uses of technology, of meeting new and changing standards for both students and teachers, and of working to help all their students succeed. Separately these are daunting tasks; together they may constitute an over- whelming burden, especially when teachers see that these goals may change in unpredictable ways at any time. However, effective professional development opportunities can support teachers in reaching these goals and lead to change in the system itself.

Characteristics of Effective Professional Development in Technology-Supported Learning

The traditional model for professional development is a deficit model of learning in which teacher-students are expected to learn from listening to experts. In the same way that education is trying to move away from this model for students, we must employ a more teacher-centered growth model for PD. Effective PD tasks:

Consider the needs and learning styles of teachers.

Present information in authentic contexts with direct links to classrooms and provide feed- back while teachers try new strategies in their classrooms.

Allow time for reflection and experience.

Are social and active in nature, allowing teachers to interact and collaborate with colleagues and mentors.

Present ways to get from A to B, not just new ideas that require an instant and complete transformation.

Focus on tools that teachers use for their own productivity.

Present information in a variety of formats.

Are made at the teacher's level. Teachers are more likely to use information that is for their grade and content than that which they have to adapt or revise to use.

Continue over time.

(Darling-Hammond, Hyler, & Gardner, 2017; Feiman-Nemser & Remillard, 1995; Lowenberg Ball & Cohen, 2000; Wells, 2007)

The most important aspect of PD tasks is that they result in improved student learning and performance over time.

Benefits of Professional Development in Technology-Supported Learning

PD that follows the guidelines for effectiveness noted above can lead to a number of important teacher, classroom, and school changes. As most authors note, professional development of teachers is central to school change. In fact, research shows that teacher quality is the most important variable in student learning (see, for example, Bird, 2017). Teacher improvement can lead to higher student achievement and to systemic changes in schools. In addition, teachers can be refreshed and reenergized by working with peers, solving classroom problems, and learning more effective ways to support the learning of all students.

THE TECHNOLOGY PROFESSIONAL DEVELOPMENT PROCESS

PD is essentially an individual enterprise because growth first takes place in individual teachers. Coughlin and Lemke (1999) and other more recent literature propose an iterative, or repetitive, growth process that teachers generally go through during effective technology PD:

Entry: Teachers do not yet have the skills and knowledge to change their practice. During this stage they

Build knowledge.

Understand possible changes.

Adaptation: Teachers use technology to support existing practice rather than to change the classroom. At this stage they

Apply (try new ideas and understandings, assess their effectiveness, adapt and change as needed, try again).

Revise their practice.

Repeat.

Transformation: Teachers use technology to help them change their practice in important ways. During transformation they

Share with colleagues.

Document successes and failures.

Evaluate the changes in both the environment and learner achievement.

Any stage can be revisited an unlimited number of times, or even skipped, as teachers work through their individual learning processes. Of course, learning and change are more complex than this simple process implies, but teachers can use this description to generally understand the process and their place in it.

Also important to succeeding in the PD process are these suggestions from enGauge (2004), which, although offered over a decade ago, are still relevant:

Stay focused on the goal of helping students.

Take on goals that are challenging but doable.

Convince others that technology and thinking skills can lead to higher student achievement.

Build on the good work that is already underway.

Collaborate to support a system-wide culture of innovation.

The PD process is similar to the independent learning processes that teachers must encourage their students to work toward. By experiencing it for themselves, teachers may be better able to support this process for their students.

Challenges for Teachers in Technology Professional Development

There can be many challenges for teachers who want to participate in PD and for those who want to work toward change based on their PD experiences. However, for each barrier there are a variety of possible solutions.

Time

Sometimes teachers are unaware of technologies that can make their classrooms contexts more effective and efficient learning environments; sometimes, when they do know, the belief that learning to use these technologies will take longer than it is worth stops them from trying. According to Hubbard (2017) and others, time is the most crucial barrier to teacher development. This may be in part because

teachers and others in the educational community see PD as something that individual teachers have to set aside large chunks of time for. But Cook and Fine state that for PD to be effective it must become "part of the daily work life of educators." In other words, time must be made by schools and districts and a community culture developed that not only allows ongoing learning but supports it as much as possible. Across the literature, educators suggest some useful and effective ways to provide the time necessary for sustained PD experiences; these include:

Restructuring the school calendar.

Using permanent substitutes.

Scheduling common planning time.

Integrating PD into classroom time.

In the end, it may come down to a trade-off—spend time learning to then teach more efficiently and effectively.

Access

Teachers cannot use technology that they cannot get to at all, and some teachers cannot get to it as often or as well as they would like. Without access to technology teachers also cannot practice new skills. Examples throughout this book provide examples of how administrators, teachers, and other stakeholders can work together to make sure that teachers have the access they need. Many teachers who have not been able to secure access to school and district resources have obtained their own technology funding through grants available from a wide array of organizations. More on funding is presented in the Guidelines section of this chapter.

Knowledge

As previously noted, there are many sources of information for teacher PD in technology- supported learning. However, sometimes local resources are the most useful. For example,

Students. Often students have technical know-how that teachers do not and can provide instruction for their whole class. Bray (2011) proposes that schools develop student experts. These knowledgeable and/or willing students can receive training before and after school for a specific amount of time and then obtain a special status and limited access to the school network. Their identifying badges let peers know whom they can call on for help and let the teacher know whom she can count on for on-the-spot instruction. YouTube videos, peers, online tutorials, and other resources are available to teach students how to use specific technologies.

Colleagues and other staff members. In-school staff may have a just-in-time answer that can save a frustrating wait for technical support people.

Teachers' guides. Guides and tutorials that accompany and support software packages apps often focus on process and provide many additional relevant activities.

Local conferences, workshops, and in-services. Many school districts, professional organizations, and state education agencies offer workshops, seminars, and conferences that either focus on technology or have a technology strand. Typically cheaper and more personal than the large national conferences, these opportunities can offer a wealth of resources, data, and relationships with interested peers. The CUE conference in California and NCCE in the Pacific Northwest are excellent examples of outstanding regional conferences.

Parents, community volunteers, school library media specialists, and school technology coordinators can also be excellent sources of knowledge and support.

Working with parents

Communicating with parents, particularly helping them to understand technology use in schools, takes time and thought. Getting parents on board with technology PD can sometimes be a struggle. To make communication with parents easier, teachers can build on other teachers' experience and download forms and letters from great sites like TeacherTools (www.teachertools.org/) or timesaversforteachers.com. Most school districts also have teacher Web pages and some kind of communication app to help teachers and parents communicate.

Working with ELL and special-needs children

In the past PD for content-area teachers did not often address the needs of all the student populations in a class; rather, issues of special needs and ELL children were addressed separately. However, with the current understandings of the effectiveness of differentiated instruction and the focus on inclusion, many more PD experiences deal with the success of all students. Clearly, teachers cannot make all of these changes themselves. Schools and communities need to support teacher PD and provide ways to meet these challenges.

## GUIDELINES FOR WORKING TOWARD EFFECTIVE TECHNOLOGY PROFESSIONAL DEVELOPMENT

Like student learning, effective teacher growth can only happen when the support and encouragement that teachers need is available. The guidelines in this section provide ideas about some ways for teachers to gain both support and encouragement and to have rewarding and effective PD experiences.

Guideline #1: Be a part of the decisions. Being on the school or district technology committee does take a commitment of time and effort. However, teachers who understand what it takes to effectively integrate technology into learning can help to make sure that technology funds pay for both the hardware and the training that is necessary.

Guideline #2: Explore alternative funding sources. Although experts recommend that 25–30% of technology budgets be devoted to professional development, it rarely is (Fletcher, 2005). In addition, millions of technology dollars each year are left sitting in organizational coffers, unclaimed by the teachers that they are meant to help. There are a variety of reasons for this, some dealing with teachers' lack of time for grant writing and knowledge of resources, others with the misunderstanding that technology grants are hopelessly complicated to complete and win. Large grants, especially those from the federal government, typically require a lot of work and are not always successful, but they can offer years of support and extensive funding. Pairing with faculty at universities or local civic organizations who can help with grant preparation and administration can be effective for all participants.

In addition, there are a large number of foundations and other organizations working to fund teachers needing specific hardware such as handhelds (search "education technology grants") or software in areas such as reading improvement. Even a small grant can provide impetus for PD and access to the technology that can make it happen. Further, many commercial software and hardware publishers offer their own grants of money and/or materials, and some

offer links and other information to help teachers. In many cases securing funding requires only a one-page description of the need; in others it is more involved, but resources exist across the Web to assist teachers in preparing grant documents.

Guideline #3: Take it slowly. As noted above, time is a crucial component in teacher professional development (Darling-Hammond, Hyler, & Gardner, 2017). Learning to use technology well does not happen quickly, but rather it is a process of learning, testing, revising, and evaluating. Just as students should not be expected to become critical or creative thinkers overnight, teachers should not be expected, or expect themselves, to become instant technology integration experts. It may be frustrating to take only small steps, but learning and change are slow processes, and in the end the small steps can add up to large gains.

**FIGURE 9.2 Guidelines for Effective Professional Development**

| | |
|---|---|
| Guideline #1: Be a part of the decisions. | Become a member of the technology committee or other organization that decides on how to allocate funding. |
| Guideline #2: Look for alternative funding sources. | Apply for small grants and/or enlist help from the community. |
| Guideline #3: Take it slowly. | Outline small steps that can lead toward large gains. |
| Guideline #4: Do not do it alone. | Work with peers, administrators, parents, and the community. |

Guideline #4: Do not do it alone. As other parts of this book have stressed, there are many education stakeholders, both direct and indirect, who can be called on to work with teachers and students. Stevenson's (2004/2005) research showed that these kinds of informal collaborations can lead to effective technology integration in the classroom, and other studies have shown the importance of school and other technology partners to successful PD (cf. Ludwig & Taymans, 2005). To support teacher PD, parents can be asked to help in all kinds of ways. For example, they can participate in funding drives, be part of dissemination or reading groups with teachers, work with the results of PD by sharing and commenting on their children's electronic portfolios, or make contact with teachers through tools like Skype. Peers at the same school and col- leagues throughout a district or across districts who have the same needs for PD can form working groups, and administrators can be invited to join to see the effect of the efforts. Even students can support teacher PD by being willing to try new ideas and tasks and to participate honestly and openly in their evaluation. Because learning is social and teachers are already isolated enough in their classrooms, PD should happen with the support and participation of others.

## TEACHER TOOLS FOR TECHNOLOGY-SUPPORTED LEARNING

This chapter started by describing three categories of teacher technology use. This section addresses administrative tools for teachers for several reasons. First, personal uses of technology are just that—personal—and so cannot be prescribed. Most teachers will find and use the tools that they need for personal productivity. Second, academic uses of technology have been described already in every other chapter of this text. Finally, the effective use of administrative tools can free time for teachers to participate in PD experiences. Administrative tools include any that help teachers prepare for, carry out, and monitor instruction (versus academic tools, which are integrated into learning tasks). Many administrative tools have been mentioned in other chapters. These include Web site generators, rubric creators, and puzzle and other activity makers. Others are described here.

Administrative Tools for Teachers

Translators/parent letters. In addition to professional development opportunities, 4Teachers has links to administrative tools. Try Casa Notes to send home notes in Spanish (www.4teachers.org/) and Google Translate for other languages.

Clip art. For great free school clip art, see discoveryschool.com's Clip Art Gallery.

Forms and handout templates. An amazing number of ready-made templates can be found at Education World's Tools and Templates page (http://www.educationworld.com/tools_templates/index.shtml). Worksheet makers allow teachers to build their own worksheets using a variety of scaffolds or to use/adapt premade worksheets.

Screen timer. Computer-based timers that show up on the screen allow everyone in the classroom to see how much time is left, which is useful for students who need to pace themselves during tasks. They have a variety of settings for different contexts. Search "screen timer" to find one that works in your classroom.

Classroom management tools. Administrative tools from Scholastic.com (http://teacher.scholastic.com/tools/) include apps, calendar and book tools, and other planning help.

Lesson planner. These apps provide guidance for teachers to write complete, standards-based, content-focused lessons. They range from the PlanbookEdu app (https://www.planbookedu.com/) to free planner pages at http://www.playdoughtoplato.com/teacher-planner/.

There are other tools that can function both as administrative and academic support for teachers and help teachers work toward PD. These include resources such as:

Atomic Learning (www.atomiclearning.com/), Linda.com, TEDTalks. Teachers can search, view, and or subscribe to participate in multimedia tutorials or lecture of their choice or incorporate student tutorials into instruction.

Pinterest (pinterest.com). Truly the best source of all things classroom, from lists of great apps and classroom posters to lesson ideas and tutorials.

LEARNING ACTIVITIES: PROFESSIONAL DEVELOPMENT

Whether teachers want to take it fast or slow, make incremental or fundamental changes, there are all kinds of activities to get them started. Right now, while waiting for funding, the district technology plan, more resources, or other support, teachers can take a step toward their larger goals and participate in any of these activities to make immediate changes in their instruction:

View sample elementary through high school activities from the Handbook of Engaged Learning Projects (HELP) (www-ed.fnal.gov/help/index.html).

Ask questions at teacher electronic discussion groups or join communities such as simpleK12 (http://www.simplek12.com/teacher-learning-community/).

Get inspired by cruising some of the coolest sites for kids on the Web. Definitely start at DiscoveryKIDS (discoverykids.com). Then visit www.iknowthat.com.

Set up a cooperative group with your colleagues at Yahoo.com, Google Groups, or another easy to access app. Use the system from home to share useful Web sites and other resources.

Create a literature circle for teachers and administrators within the district and work through one of the books on technology that the group has been meaning to read.

Take an inspirational virtual journey. Take a private museum tour through one of the 33,000 museums connected to http://museumnetwork.com. Be sure to check the MuseumEducator.org link to access teacher resources from museums across the United States.

Visit a new "world" – choose from among those recommended by Wheelock and Merrick (2015; https://www.iste.org/explore/articleDetail?articleid=395).

Subscribe to an online educational technology journal, magazine, or newsletter. Try From Now On (http://fno.org) for an easy and useful read or any of the newsletters from Education World. The free daily SmartBrief on EdTech is chock full of news, ideas, competitions, grant announcements and more (sign up at www.smartbrief.com).

Choose a relevant tutorial from i4c (www.internet4classrooms.com/on-line2.htm; Technology Tutorials for Teachers (eduscapes.com/tap/ topic76.htm), 2learn.ca (www.2learn.ca/teachertools/teachertools.html), or PBS Technology Tutorials (www.pbs.org/teachersource/teachtech/tutorials.shtm). Be sure to share when done.

Visit the Motivating Moments Web site at www.motivateus.com/teachers.htm for inspiration.

Read a book to obtain a different view of educational technology. Classics include:

Johnstone, B. (2003). Never mind the laptops: Kids, computers, and the transformation of learning. New York: iUniverse.

Cuban, L. (2002). Oversold and underused: Computers in the classroom. Cambridge, MA: Harvard University Press.

Bowers, C. (2000). Let them eat data. How computers affect education, cultural diversity, and the prospects of ecological sustainability. Athens, GA: University of Georgia Press.

Ferneding, K. (2003). Questioning technology: Electronic technologies and educational reform. New York: Peter Lang.

Khine, M., & Fisher, D. (2003). Technology-rich learning environments: A future perspective. New Jersey: World Scientific Publishing.

There are many ways that teachers can jumpstart their PD—the activities listed above constitute only a small portion of them.

## ASSESSING PROFESSIONAL DEVELOPMENT

The ultimate goal of evaluating teacher technology PD is to determine whether professional development promotes using technology to improve student achievement. Assessment of PD can take many forms and involve many people, such as:

An evaluation team. Darling-Hammond, Hyler, and Gardner (2017) recommend that a team be created to ensure the quality of the professional development experience(s) and help perform both formative and summative analyses of the process. This team can consist of an administrator, a technology staff member, a content-area peer, and the teacher, or any combination of participants who are able to evaluate the experience.

Teacher self-assessments. Teachers can reflect both on the experience and on the long-term effects.

Student data. Achievement data in the form of test scores, grades, and student self-reflections can be collected over time to evaluate the impact of the changes.

Like planning classroom experiences, evaluation of PD experiences should be part of the process from the beginning. NCREL (2004) recommends the following evaluation process:

Clarify goals and assess their value.

Analyze the context.

Explore the PD program’s research base and evidence of effectiveness.

Determine multiple indicators for assessing goals and define who will gather what evidence when.

Collect and analyze evidence on participants’ reactions, learning, and use of new knowledge and skills. Also, look at evidence of organizational support and change and student outcomes.

Present the results to all stakeholders and suggest possible changes.

The results of these assessments can help teachers and others to choose effective PD experiences and to work toward technology integration in a purposeful way.

FROM THE CLASSROOM

Connections

When I attended [a conference] this year, the state PTA president gave a workshop around parent involvement. One example they gave was the use of classroom-produced videos. Some students have parents unable to read, unable to attend open house, etc., but most families now have a television and VCR. Videos were created by teacher and students (could get volunteers to do the recording) showing parents: students at work, classroom goals, suggestions for helping with homework. In other words, an overall picture of the child's classroom. The response has been tremendous, and the payoff is that more parents want to come to the school. Another suggestion, which has been tried at our school, is the use of technology during staff meetings. PowerPoint presentations are made (the principal has tapped into the staff members with technology knowledge and skill), staff use the AlphaSmarts during staff meetings to look up info or type notes, videos are shown showing teachers (from our school) using examples of good teaching practices. (Jean, middle school teacher).

Barriers

Our school applied for a grant and received five computers for every sixth-grade classroom. We have had mostly problems. As teachers, we attended staff development, continued to learn on our own, have the students use the computers for drill-n-practice, to gather information. Unfortunately, as the computers crashed, the district did not provide technical support. We have had to pay for any maintenance and for additional wiring. In several of the sixth-grade classrooms, nonfunctioning computers sit on the floor because no one seems to want to fix them or take them away. Other schools have received fewer computers, but they were bought by the district and technical support is provided. This is a good example of where more information and asking questions should have happened before accepting the "free" computers. (Jean, middle school teacher)

The person in charge of choosing the software in our building is very well trained and knowledgeable about the software we purchase. The problem? Well, our tech coordinator is also our librarian. She is always swamped with questions and troubleshooting. The problem has become so huge, we now have a little basket where we fill out our questions/headaches, etc., and a district technician comes by about once a week to go over the "yellow slips." (Andrea, elementary bilingual teacher)

Sharing

Accountability to the state is important, but what about to the students? If they are only being trained how to take a test that is not a fair representation of their knowledge, how are they learning the valuable skills of working collaboratively to solve complex and real-life problems? Perhaps you could start slowly, by adding a few authentic learning activities where students will be learning the discrete knowledge they need for the test, but can also have an opportunity to apply it in some manner—perhaps with technology. Your situation with computers that do not have Internet access or word processing programs is quite eye-opening! It sounds as if you are in need of at least one decent computer with a basic software program to start with. If that isn't available, there are other forms of technology that some parents in the community might be willing to loan the classroom for a day or two: video cameras, laptops, digital cameras, tape recorders, typewriters, etc. And once you can get a few of these technologies, you can begin to help your students meet the NETS standards for students. Now, it sounds as if you aren't very comfortable with teaching students how to use these technologies. No fear! I've known many teachers who use various strategies to get around this barrier. First, begin with what you do know and teach a few select students. Those students can then become experts and share their "knowledge" with others in the class.

Perhaps there are older students in the school or high school who would be willing to volunteer an hour or two every week and do the same. I think you'll be surprised with the wealth of knowledge available to you in the form of your students in your own district. To help your students become independent users of the technology to save you time for teaching and instruction, you can make a list of various skills and knowledge and have student experts sign their names under each that they qualify for, so that the class will know where to go when they encounter a question or problem. Also, as you have various groups of students coming and going throughout the day, it might be helpful to open up your classroom during recess once a month or so and train a few of your experts. While these are only suggestions, I want to encourage you not to give up on technology but to continue making baby steps with what you can do and do have available to you by using a few creative strategies to overcome the barriers you encounter. (Jennie, elementary teacher)

## CHAPTER REVIEW

### Key Points

Understand the role of professional development in technology-supported learning in student achievement and school change.

Teacher quality is the most important variable in student learning. Although many factors determine how teachers think and act, it is clear that they hold the key to student achievement.

Discuss guidelines for professional development in technology-supported learning.

A thoughtful, reflective approach to PD will help teachers get the most out of each experience. Working

with peers and other stakeholders and being part of the decisions, whether on funding, class size, or technology purchases, can also make a difference.

Evaluate tools for teacher development in technology-supported learning.

An amazing array of tools exists for teachers' personal, administrative, and academic uses.

Discover and participate in effective activities to support technical and pedagogical development.

Teachers must develop their understandings about learning and about technology. Even activities as simple as reading an article or playing with a new tool can play a role in teacher learning.

Assess your own development in technology-supported learning and teaching. Although multipoint, multi-evaluator assessment provides a clearer overall picture of PD experiences, teachers can use many of the self-assessment tools found in books and on the Web to reflect on their own changes and on changes to their classrooms and schools.

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# 13
# Chapter 10 Supporting Your Students' Futures

This chapter is a bit different from the others. First, it is shorter than the others because only so much speculation is useful. Second, the focus is to prepare you for the relatively unknown. Al- though guidelines are possible, concrete applications for the future are probably not as useful as they are for the present. This is particularly true not only because technology will change, but because standards, goals, and curricula will also change. Even the definitions of "schooling" and "education" may change while you are in the classroom. In other words, there are many ways that the future of education could take shape, each with its own advantages and disadvantages.

It's hard to say, for example, what learning goals will be in the future— the pendulum between learning to think and learning test-focused basic skills swings back and forth with regularity. It seems logical to be able to have students do both. Other chapters in this text show that basic skills are crucial to more open-ended learning, and students can mix skill learning with other more open instructional goals and succeed in both. For now, it appears that this dual focus will serve students well in the future. In addition, organizations that have developed national standards suggest that these standards will carry us far into the future. They note that the emphasis on thinking skills, building communities of learners, and both process and outcomes not only will take some time to implement fully, but will also prepare students for future challenges.

Therefore, the goal of this chapter is to help you to understand current trends in learning to teach with technology to help you prepare as much as possible for the future. Although it may be hard to look ahead when you're just getting started, you should be aware of changes that might affect your classroom so that you can work with the changes instead of being surprised by them.

After reading this chapter, you will be able to:

Understand trends that indicate where learning and educational technology might be headed.

Describe guidelines to help you support students in the technology-enhanced future.

Reflect on current trends in technologies.

Help students think about the future through technology-supported activities.

Assess how well your students are prepared for their technology-enhanced futures.

The discussion, sample activities, and tool descriptions throughout this chapter will help you understand the many opportunities that the future may present. As you read this chapter, consider how you might work to make the best of these opportunities.

## OVERVIEW OF FUTURE TRENDS AND EDUCATIONAL TECHNOLOGY

Rapid technology changes occur constantly in health, medicine, science, and other fields. Many of these advances will eventually arrive in educational settings, but which and how useful they will be is a question. Many people are making predictions, suggestions, and statements about the future of education and educational technology. Some predict that schools built of brick and mortar will no longer exist and that the boundaries of education will be as broad as cyberspace. Others suggest that technology will increase the distance between the educational haves and the have-nots.

No one knows what the future will bring. However, it is possible to look at the past and present and develop some general predictions. Why should teachers look 5 years, 10 years, and even longer into the future? Teachers should have an idea what their students will have to be able to do in 2025 or 2030 in order to understand how to prepare them.

## LEARNING TRENDS

Looking at current trends is a fruitful way to predict what the future might bring. Information on the trends discussed in this chapter has been gleaned from the popular press, the Internet, and other media outlets. There are as many alternative views as there are trends described here, and they make for interesting reading and discussion for teachers and students alike. The trends highlighted here are likely to affect education in important areas such as funding, demographics, and sources of information.

### Trend 1: Universal Access and Use

At the turn of the recent century, according to the Forum on the Future of Technology in Education (U.S. Department of Education, 2000; http://www.air.org/forum/issues.htm), the following priorities were emerging for technology in education:

All students and teachers will have universal access to effective information technology in their classrooms, schools, communities, and homes.

All teachers will effectively use technology.

All students will be technologically literate and responsible cybercitizens.

Research, development and evaluation will shape the next generation of technology applications for

teaching and learning.

Education will drive the eLearning economy.

Almost two decades later, these priorities for universal access and use of educational technology are still only partially implemented. In other words, they have not been completely realized. This may be in part because many of the same barriers noted in the U.S. Department of Commerce report Falling Through the Net: Toward Digital Inclusion (2000) still exist. The report showed that students with disabilities or those living in impoverished conditions had less access to technology than others. First language, level of education, and age also continue to affect how technology is accessed and used. In addition, the U.S. gender gap that previously existed in who uses technology has not closed, and reports show that there are differences in why and how males and females use technology such as the Internet (Pew Internet and American Life Project, 2007; Price, 2016).

If, in fact, the priorities of universal access and use are to be met, attention must be paid to students' circumstances both within and outside of school. Administrators and teachers need to think about new ways to allocate the computers in their buildings, as noted in chapter 2. They also need to notice which students are using computers more frequently and support those with less confidence or less assertiveness. In addition, schools need to help students be flexible and effective in why and how they use technology.

Communities are working toward addressing these issues in a number of ways, including starting financially supported student laptop programs (e.g., see a story about East Rock School District at www.education-world.com/a_issues/schools/schools020.shtml), creating community computing centers, and funding more technology for public libraries (e.g., see the Public Library Association site at www.ala.org/pla). The results of these programs are not yet in, and some have generated controversy (for example, see reports supporting 1-to-1 laptop programs such as Doran and Herold, 2016, and an argument against it in Schrader, 2016). However, if these solutions prove workable they should have an impact on this trend.

One trend that has recently gained momentum is the move to Open Educational Resources (OER). This movement supports free digital materials across the curriculum; these include books, videos, and more. According to Rayl (2017):

OER allow educators to adapt instructional materials to the individual needs of their students. This helps ensure that content and resources are up to date and relevant and fit the unique needs of diverse student populations. Because of publishing timelines, traditional classroom materials like textbooks can often be out of date by the time they're implemented in the classroom. And that doesn't even take into account the curriculum adoption cycles that exist in most districts, which result in content areas updating resources on a two-, three-, or four-year rotation due to budgetary constraints.

OER also guarantee that cost is not a barrier to accessing high-quality, standards-aligned resources.

A number of OER repositories exist, including OER Commons (www.oercommons.org), Curriki (www.curriki.org), and OpenEd (www.opened.com). The benefit of these sites is that resources are vetted and aligned with standards. This is not always the case, however, and teachers must be wary of "free" resources that are not officially Creative Commons licensed but rather are clickbait (tempting) or lead to a commercial web site. OER resources can be remixed, revised, and distributed freely. Adapted versions can even be uploaded for others to use. For additional OER resources, see Rayl (2017).

Trend 2: Coding

The trend toward an emphasis on science, technology, engineering, art, and math (STEAM), along with the focus on critical thinking skills, supported from the federal government to business to school standards, means a greater emphasis on students learning to code. Coding programs are starting as early as kindergarten, with simple coding programs like Blockly and Hopscotch (for others, see Patterson, 2014). At upper levels, code.org and other programs provide videos, tutorials, practice, and examples to help both teachers and learners with coding. Learners can even code in Minecraft, a very popular open-ended sandbox app used from K-12 both within and outside of school. Learning to code is expected to help learners think analytically, create, produce, and communicate in addition to being prepared for the very technological future that they face. However, teachers cannot teach coding if they do not understand it themselves. Myriad teacher resources exist, from Davis (2016) to local volunteers sponsored by Hour of Code (hourofcode.com/us). Some states are even including coding in their standards and are working on requiring teachers to have a computer science endorsement in the future. Teachers can get a head start by checking the resources noted above and searching for additional ones on the Internet.

Trend 3: Web 3.0

An important trend in technology in the last 15 years or so was that more people could contribute to and participate in media. With the advent of social computing, called "Web 2.0," students were building social networks and connecting to other users through blogging, creating wikis, programming virtual worlds, developing lists of social bookmarks, and supplying video, audio, graphics, and text to be shared with millions of unknown users around the world in forums such as Facebook, Twitter, and Snapchat.

Most of this happened outside of classrooms, but more recently some teachers have taken advantage of this trend and used some of these tools in effective instruction. These tools are used to help learners see different perspectives, learn to write for an audience, create information that should be shared, and meet other learning goals.

Predictions say that the so-called "Web 3.0" (coined by John Markoff, a New York Times reporter, in 2006) or "intelligent Web" will take this trend to another level, with web browsers that learn what people know and like and can function as personal assistants. Based on artificial intelligence, the

computer will be able to understand information that humans provide in the same ways that the users do and adapt to the users' needs. The computer will be able to understand words, sentences, and contexts and connect users across multiple platforms and devices seamlessly.

One advantage for students of Web 3.0 could the ability to study anything anywhere, on any device, and still be connected to a teacher and class. Another benefit may be the ability to more easily use voice and other types of commands and receive exactly what was searched for, rather than hundreds of possibilities.

However, just like one possible disadvantage of the proliferation of social Web sites and other tools is the tendency of students to believe what they read, Web 3.0 can make the need for declarative and procedural knowledge seem unnecessary to students. Exercises and tools that facilitate student critical thinking (such as those in chapter 4) will be more crucial than ever if this trend continues. In addition, risks inherent in Internet use by minors increase with more time, information, and accessibility online, and all stakeholders must ensure that safety policies (chapter 3) are effective.

These trends may or may not continue and may or may not have the suggested impacts on education that their supporters believe. However, teachers must be aware and prepared to respond to these changes.

### Future Roles of Teachers

The traditional role of teachers as information-givers has changed, as noted throughout this text. Teachers need to and are becoming facilitators, co-learners, and mentors. However, change is slow in education. Although new technologies are often seen as the agents of change, only teachers can make changes in pedagogy (such as creating new kinds of tasks, integrating technology in effective ways, and providing support and feedback that meets the needs of individual students).

As the availability and importance of technologies change, teachers must be able to address the academic, linguistic, and social needs of students so that all students have opportunities to learn. Trends that are beginning to help teachers become change agents in their students' lives include emphasis on social justice, equity, cultural responsiveness, differentiation, and access to information. The guidelines throughout this text that focus on these issues may play an even more important role in the future.

## GUIDELINES FOR SUPPORTING STUDENTS IN THE TECHNOLOGY-ENHANCED FUTURE

All of the learning goals outlined in this text aim at supporting students' learning, and in doing so also address students' futures. Teachers can implement the following guidelines now to help students meet

the goals and be ready for the future.

Guideline #1: Help students handle information. Students are often bombarded with information from multiple sources when they are using computers, cell phones, and other technologies in class. Teachers must be aware of the divided attention or distraction that results from the overwhelming amount of information. Teachers need to help students sort out what is important in the information stream and how to organize and use it. Some students will feel at home with the flow of data, and others might get lost. Strategies for teachers include:

For students who are comfortable with it, “continuous connectivity” allows them to tap into what is called the “back channel,” gathering information to support the task or event they are working on through numerous resources. Teachers can allow these students to access a variety of resources at the same time and teach them how to give credit to the authors of the sites they access.

Other students may need more structured, selective use of technology. Teachers should carefully preselect Web sites or software modules and provide step-by-step instructions on how to proceed.

A flood of information can support learning for those who can multitask, but it can also create barriers to true, face-to-face social interaction from too much attention to technology. By observing and working with students, teachers can work toward an appropriate balance of technology use and social interaction for each student.

Guideline #2: Keep an eye on trends. Knowing where education and educational technology are going (and should go) means being aware. Teachers should consult useful resources such as ISTE’s Web site, news media Web sites such as CNN and MSNBC, and blogs and other resources that directly address the future of technology. Teachers can also enlist students in finding and presenting information about trends, documenting where the trends seem to be going, and mapping the trend as it progresses.

One interesting site to review is Imagining the Internet: A History and Forecast, provided by Elon University and the Pew Internet Project (www.elon.edu/e-web/predictions/publications.xhtml). The 2006 survey, The Future of the Internet II, asked hundreds of technology experts to look at trends and predictions for the year 2020. The site creators provide teacher tips and tools for teaching about the future and working with predictions, including “Back 150 Years,” “Forward 150 Years,” and a KidZone.

## TRENDS IN TOOLS AND TOOL USE

There are so many emerging technologies and changing uses of tools that it is often difficult to keep track. By the time you read this book, blogs, wikis, podcasts, and other “new” technologies may be commonly used in schools, increasing online interactions and collaboration and providing a variety of students with access to content and skills. Google for Education, MinecraftEDU, and other tools will be prevalent in K-12.

This section lists tool trends that could affect education in the near and far futures. They are not listed in any particular order, because all could equally signal important changes to educators.

A move away from commercial operating systems like Microsoft and MacOS to Linux and other open-source, free programs. This is currently a slow-moving trend that is gaining momentum. Since many of the programs that schools currently use may not work on these new operating systems, it may impact school economics.

A move away from desktop machines to integrated mobile units. Technologies are combining, and some of them are wearable. For example, GPS, cell phones, and watches; blogs with video (e.g., www.vidblogs.com); courseware that includes telephony software like Skype. The trend toward mobile computing means that students can access information almost anywhere. This implies that the classroom of the future might be wherever the student is.

Internet telephony (Voice over Internet/VoIP). Programs such as Skype are taking the financial burden out of instant voice connections and allowing students and teachers to communicate with authors, artists, scientists, and classrooms around the world. These free programs are changing the economics of electronic voice connection and the possibilities for schools to use it. However, VoIP requires a fast connection, so it is still not available in some schools.

Ease of use. Technologies are getting easier to use as interfaces become more supportive, more visual, and more user-friendly. For example, to find specific items in a Web or site search, users used to have to type special symbols and order terms in a certain way. Now most browsers do not require the “http://” in front of the URL, and symbols are rarely needed.

Additionally, animation software like Animation Master (hash.com) makes it easy for people to do simple animations. Students can create animations of stories, concepts, and ideas to help their audience understand their presentations. Also, Web sites are using new coding and software to make them more interactive and responsive to users’ needs. Many sites include site searches provided by Google and instant technical support through telephony software. All of this makes these tools and information more accessible to a wider range of users.

In the far future, advances in virtual reality, wearable computing, and other technologies may allow even greater access to information and communication. However, teachers must make sure that these and other technologies are used effectively, responsibly, and in pursuit of learning goals, as outlined throughout this text. In part, this means teacher digital literacies and online safety. For more information, visit WiredSafety.org.

## ACTIVITIES TO PREPARE STUDENTS FOR THE FUTURE

One way to prepare students for the future is to facilitate their progress toward the learning goals that

frame this text. Another way is to have them start thinking about the future using both real and fantastic approaches. The activities in this section incorporate both of these ways. Each activity is listed with a short description and possible resources. All of the examples address a set of the learning goals. Each activity can be adapted to suit student needs, interests, and context.

Example 1. Tools of the future

Students:

Think about what technology might be able to do in the future.

List current problems that technology use could solve.

Predict what problems the technology could cause.

Create a “documentary” or opinion piece to present their ideas.

Use Time Travel resources from Nova (http://www.pbs.org/wgbh/nova/time/resources.html) to engage students in the unit and get them thinking and other Web sites for support and development (e.g., Creating a Documentary from Apple at www.apple.com/ education/documentary/).

Example 2. Future occupations

Students:

Access lists of current occupations.

Chart the current and future need for the occupation based on data.

Note how technology might change the occupation.

Create an advisory bulletin (news report, pamphlet, FAQ file) for students making career decisions.

Use occupational trend data found in the Occupational Outlook Handbook from the Bureau of Labor Statistics (BLS; www.bls.gov/emp/) to get started.

Example 3. Fortune-telling

Students:

Examine the basis for and veracity of fortune-telling.

Choose a type of fortune-telling—e.g., palm reading, tarot cards, the stars, a crystal ball—that is of interest to them (and that does not go against any of their beliefs or expected behaviors).

Explore the background of their chosen method, including its cultural significance.

Create a presentation or product to show others what they found and what they believe about it based on evidence they collected.

Resources include library- and Internet-based texts, Web sites, experts, readings, and practitioners. Students can start with definitions in encyclopedias such as Wikipedia, then check fun sites such as iVillage's Crystal Ball (https://www.horoscope.com/us/games/divination/game-crystal-ball.aspx), Fortune Cookie ( https://www.horoscope.com/us/games/divination/game-fortune-cookie.aspx), and GenieSays.com's Genie (www.geniesays.com/). Other background information can be found in Leland's historical account of fortune-telling (www.sacred-texts.com/pag/gsft/index.htm),

Example 4. The most important question

Students:

Determine the most essential questions to answer about the future.

Brainstorm, consult peers, family, and experts, and use feedback from a data-collection site on the Web to compile a list of questions.

Develop criteria for narrowing their list (perhaps "affects the most people," or "easiest to answer").

Debate, survey, or use other methods to determine which questions best fit their criteria.

Figure out ways to try to answer the questions.

Share their answers in an appropriate format with those who provided input.

Resources can include blogs or Web forms, email, articles and readings, and production technologies. Students can get ideas and opinions from The Speculist blog (Seven Questions about the Future; www.speculist.com/archives/000019.html) or ABC News experts (http://abcnews.go.com/Technology/ces-2015-biggest-tech-trends/story?id=27966276).

These brief examples show how teachers can integrate knowledge and ideas about the future, crucial learning goals, and educational technologies to support student learning.

## ASSESSING STUDENT PREPAREDNESS FOR THE FUTURE

Students will need to be more independent, resourceful, and technologically literate in the future. Many of the assessments described throughout this text can help you to understand where your learners are proficient and where they need more support. Evaluation can assist teachers and students in understanding where to put more effort so that students meet the goals they need to be successful. Teachers and students can adapt checklists and rubrics to their contexts and beliefs about the future.

For example, the language may need to be simplified or examples provided for some learners, while additional criteria addressing what students need in the future could be added.

Students can use checklists to evaluate their skills as independent, resourceful, prepared learners. Students can complete the appropriate rubric one or more times and reflect with their teacher on where they need to improve. Then teachers and students can make a plan for how to achieve the goals on the checklist. For example, to use time more wisely, students may make a list of ways that they typically do not do so and then have a peer or the teacher remind them to check it. Likewise, students can keep running records of their progress on a criterion such as participating in the group, noting when they participate most effectively and working to enhance those group features that help them to participate. The checklist criteria could also be posted around the room to remind students to reflect upon them every day. Such evaluation checklists could be usefully integrated into a portfolio or a progress report.

Through assessments like these, teachers can help students to invest their time and effort in tasks and skill-building that will serve them well in their futures.

It is not certain that the changes suggested in this chapter will or even should happen. In fact, with every gain, some kind of loss is experienced. This idea is underscored by some of the trends presented in this chapter. For example, when networking becomes more social, the amount of face-to-face interaction appears to decrease. Or, as computing becomes more mobile, student expectations of schooling might change in ways that schools are not ready for.

According to Bruce Sterling (2005), author of Shaping Things, there are two future scenarios that technology might help bring about—greater community around the world that leads to peace, prosperity, and a cleaner, fairer world, or a government-ruled, 1984-type future where the flow of information is controlled by the elite. Either is just as likely as a lot of other visions, but teachers must prepare to have an important role to play in the outcome.

CHAPTER REVIEW

Key Points

Understand trends that indicate where learning and educational technology might be

**headed.**

Experts and others continue to make a variety of predictions about the future, some of which appear more likely than others to happen. What seems clear is that technology and education will change.

Describe guidelines to help you support students in the technology-enhanced future. Teachers must help students find a comfortable place in the flow of information and keep up on trends that might affect their teaching contexts.

Reflect on current trends in technologies.

Many technologies are changing so rapidly that it seems impossible to keep up with them. It is important to be aware of those that can help students meet their learning goals and to focus on effective use of whatever technology is employed.

Help students think about the future through technology-supported activities.

Well-crafted activities can help students meet learning goals as they think about and imagine what the future may bring.

Assess how well your students are prepared for their technology-enhanced futures. Part of this assessment is helping students be aware of their current knowledge and skills and to understand where they need to be better prepared for their futures.

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