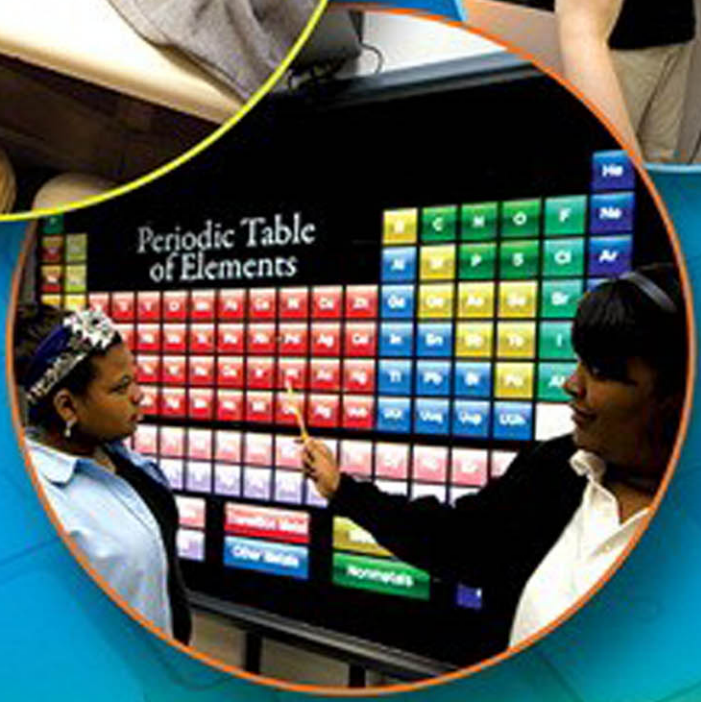
M.D. Roblyer

INTEGRATING EDUCATIONAL TECHNOLOGY *into* TEACHING

SEVENTH EDITION



SEVENTH EDITION

Integrating Educational Technology into Teaching

M. D. Roblyer
Nova Southeastern University

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For Bill and Paige Wiencke, whose love is,
as Arthur Clarke said of advanced technology,
indistinguishable from magic.

—MDR

ABOUT THE AUTHOR

Photo courtesy Paige Wiencke

M. D. Roblyer has been a technology-using professor and contributor to the field of educational technology for over 30 years and has authored or coauthored hundreds of books, monographs, articles, columns, and papers on educational technology research and practice. Her other books for Pearson Education include *Starting Out on the Internet: A Learning Journey for Teachers*; *Technology Tools for Teachers: A Microsoft Office Tutorial* (with Steven C. Mills); *Educational Technology in Action: Problem-Based Exercises for Technology Integration*; and the most recent text, *Introduction to Instructional Design for Traditional, Online, and Blended Environments* (2015).

She began her exploration of technology's benefits for teaching in 1971 as a graduate student at one of the country's first successful instructional computer training sites, Pennsylvania State University, where she helped write tutorial literacy lessons in the Coursewriter II authoring language on an IBM 1500 dedicated instructional mainframe computer. While obtaining a PhD in instructional systems at Florida State University, she worked on several major courseware development and training projects with Control Data Corporation's PLATO system. In 1981–1982, she designed one of the early microcomputer software series, *Grammar Problems for Practice,* in conjunction with the Milliken Publishing Company.

Currently, Dr. Roblyer is Adjunct Professor of Instructional Technology and Distance Education (ITDE) at Nova Southeastern University, chairing dissertations for ITDE doctoral students. She serves on editorial boards of various technology and research journals and is past-president of two AERA special interest groups. She is married to fellow FSU PhD William R. Wiencke and is the mother of a daughter, Paige.

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PREFACE

After a three-year gestation, the first edition of this textbook emerged in 1996—and what a time to be born! Digital technology in education too, was an infant, on the threshold of becoming a very capable, very unpredictable child. It appeared to have potential, as any youngster does, but how could we have known how far it would go and how thoroughly and unexpectedly its transformation would transform us? This book has grown along with it, chronicling its advances and our responses to them over the years. In those early days of the Digital Age, educators, like the rest of the planet, were taking their fledgling first steps onto the World Wide Web; the first edition of this text was also the first to predict that the Internet would become a major distance education technology. Since then, the tools have become more capable, diverse, and ubiquitous, and societal interest in digital technologies has segued into obsession. But the greatest challenge remains as constant as a compass: deciding how best to make use of technology's prodigious possibilities. As Richard Florida (2013) said when describing the rise of robots in the workplace, it is not our technology that defines us. Rather it is how we choose to fit it to our needs.

In this seventh edition of *Integrating Educational Technology into Teaching*, as in past ones, I seek to go beyond describing the technical features and capabilities of 21st century technology tools to focus ever more on the teaching and learning strategies they can support. What have we learned so far that enables an enlightened view of technology in education? The following are some clearly defined guidelines on what works best when it comes to matching the needs of the educational community with technology's capabilities:

- **Good pedagogy comes first**—Advancements in distance education in the late 1990s and in knowledge sharing in the years afterward gave renewed support to those who predicted, as did their predecessors in the 1960s, that technology would decrease or eliminate the need for teachers. However, our experience with these very capable technologies has shown more clearly than ever that the interaction between teachers and students remains an essential quality of effective education. This textbook proposes that technologies are, above all, channels for helping teachers communicate better with students—ways of making their relationships more meaningful and productive. It can make good teaching even better; it cannot make bad teaching good. Consequently, technology-using teachers can never be a force for improved education unless they are first and foremost informed, knowledgeable shapers of their craft. Before integrating technology into their teaching, educators must know a great deal, for example, about why there are different views on appropriate teaching strategies, how societal factors and learning theories have shaped these views, and how each strategy can address differing needs.
- **Technology is us**—Rather than seeing technology as some foreign invader here to confuse and complicate the simple life of the past, we can recognize that technology is very much our own response to overcoming obstacles that stand in the way of a better, more productive way of life. As Walt Kelly's "profound 'possum" Pogo said, "We have met the enemy, and he is us." Technology is the tools we fashion and the ways we choose to use them to solve problems in our environment. Turmoil will accompany the transitions as we adapt to the new environment we ourselves have created. But technology is, by definition, intended to be part of our path to a better life, rather than an obstacle in its way.
- **We control how technology is used in education**—Finally, we must recognize the truth of Peter Drucker's statement: "The best way to predict the future is to create it." Both individual teachers and teaching organizations must see themselves as enlightened shapers of our future. Each teacher must help to articulate the vision for what the future of education should look like; each should acquire skills that will help realize that vision.

WHAT'S NEW IN THE SEVENTH EDITION

Best known for its technology integration strategies grounded in strong research, the seventh edition of *Integrating Educational Technology into Teaching* offers a total technology integration package across all content areas that gives your students practice with technology tools as they learn how to incorporate technology into the curriculum to support and shape learning. This edition includes a number of additions that reflect changes in the field of educational technology.

- **NEW!** Chapter 1 has new coverage of issues that affect technology integration such as the need for digital literacy and digital citizenship, as well as information on new methods and technology formats such as Bring Your Own Device (BYOD) and Massive Open Online Courses (MOOCs), and expanded uses of access tools such as tablets.
- **NEW!** Chapter 2 has expanded coverage of each of the relevant behaviorist, cognitive, and constructivist learning theories that underlie technology integration strategies.
- **NEW!** Chapters 6 through 8 have been re-organized to emphasize the rapidly expanding role of online tools and strategies. New coverage includes methods to teach digital literacy and digital citizenship, new uses of social media, and design and use of online and blended learning formats such as flipped classrooms.
- **NEW!** Chapters 9 through 15 each offer strategies and a content-specific rubric that teachers can use to direct and self-assess their growth in technology integration.
- **UPDATED!** All chapters have updated research and examples for tools and/or strategies.
- **UPDATED!** Each chapter has been updated and new content has been added to document and illustrate major changes and trends in the field, such as the new emphasis on:
  - Blended learning (e.g., the flipped classroom)
  - Social media and networking
  - Virtual courses and virtual schools
- **NEW INTERACTIVE ETEXT FEATURES!** An all-new Pearson eText version includes the following interactive features in each chapter:
  - **Author-recorded BIG IDEAS OVERVIEWS (BIO)** on main chapter concepts and points to guide reading.
  - **Top Ten** (in Chapters 1 and 3–8) features highlight and describe the best software features, uses, and strategies for teachers to apply.
  - **Top Ten Must-Have Apps** (in Chapters 9–15) have been recommended by experts in the content area and present apps that are widely used in society; examples help educators see the role these tools are beginning to play in education.
  - **Links to video** illustrations and commentaries from practitioners in the field.
  - **Interactive Technology Learning Checks (TLCs)** at the end of each major section are matched to each chapter learning outcome. These help readers apply the concepts and ensure that they master each chapter outcome.
  - **End-of-chapter Technology Integration Workshops** now include links to a **Technology Application Activities** and a **Technology Lesson Plan Evaluation Checklist** that teachers can use to select most effective integration strategies.

CORE PRINCIPLES AT THE CENTER OF THIS TEXT

The purpose of this book is to show how we are challenged to shape the future of technology in education. How we respond to this challenge is guided by how we see it helping us accomplish our own informed vision of what teaching and learning should be. Our approach to accomplishing this rests on four premises:

1. **Instructional technology methods should be based in both learning theory and teaching practice**—There is no shortage of innovative ideas in the field of instructional technology; new and interesting methods come forth about as often as new and improved gadgets. Those who would build on the knowledge of the past should know why they do what they do, as well as how to do it. Thus, various technology-based integration strategies are linked to well-researched theories of learning, and we have illustrated them with examples of successful practices based on these theories.

2. **Uses of technology should match specific teaching and learning needs**—Technology has the power to improve teaching and learning, but it can also make a teacher's life more complicated. Therefore, each resource should be examined for its unique qualities and its potential benefits for teachers and students. Teachers should not use a tool simply because it is new and available; each integration strategy should be matched to a recognized need. Do not oppose experimentation, but do advocate informed use.

3. **Old integration strategies are not necessarily bad; new strategies are not necessarily good**—As technologies change and evolve at lightning speed, there is a tendency to throw out older teaching methods with the older machines. Sometimes this is a good idea; sometimes it would be a shame. Each of the integration strategies recommended in this book is based on methods with proven usefulness to teachers and students. Some of the strategies are based on directed methods that have been used for some time; other strategies are based on the newer, constructivist learning models. Each is recommended on the basis of its usefulness rather than its age.

4. **A combination of technological, pedagogical, and content knowledge is necessary**—This textbook maintains that that teachers not only need to know the content they are teaching and good pedagogical strategies for connecting students with content, but must also recognize how to integrate technology into pedagogy to achieve greatest impact on desired outcomes. In other words, teachers need what the field now refers to as a combination of Technological Pedagogical Content Knowledge or Tech-PACK.

The goal of this edition is for teachers to see more clearly their role in shaping the future of technology in education. This book illustrates that great education means employing technologies to fulfill the vision they make possible: a worldwide social network and a global community that learns and grows together.

FEATURES OF THIS TEXT

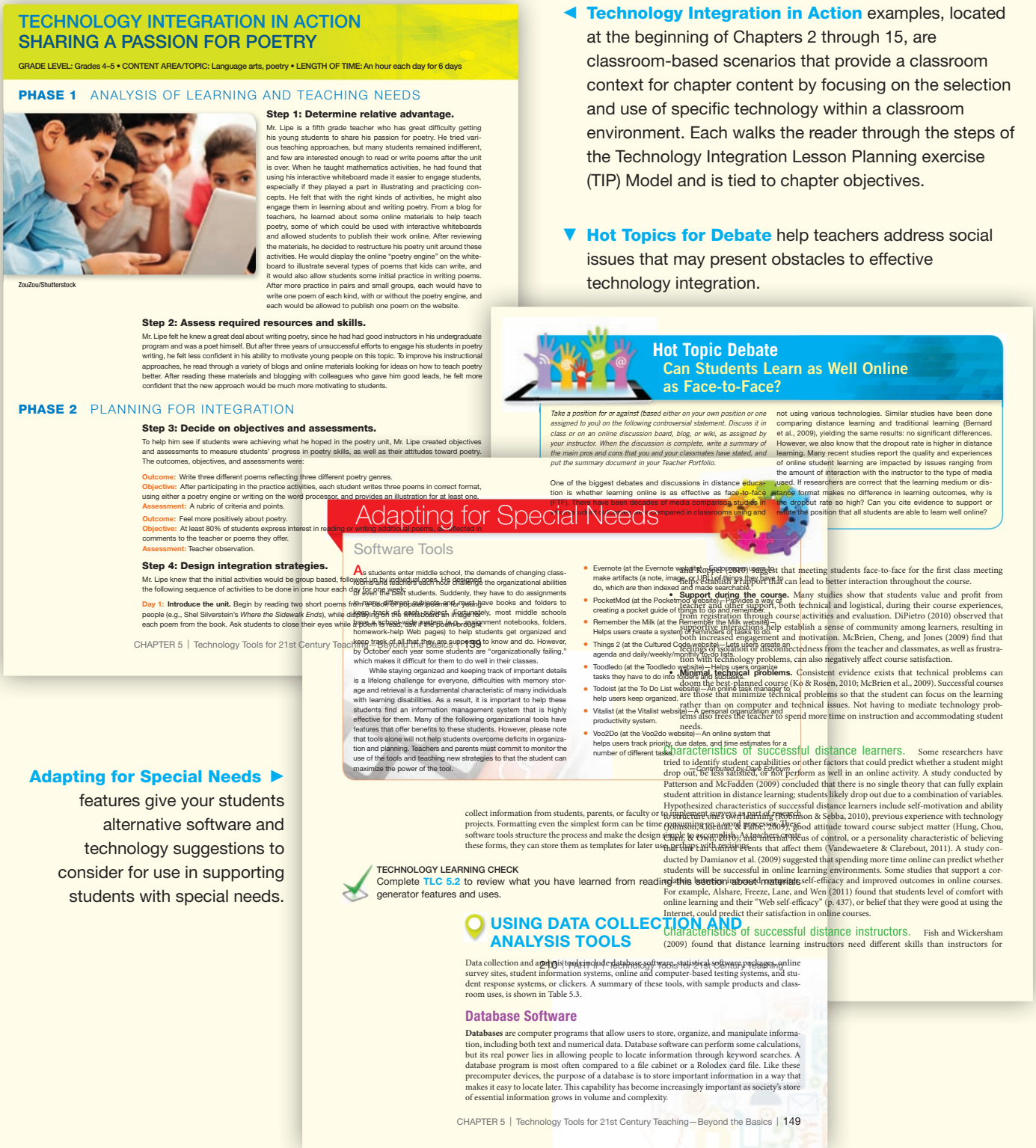
For the seventh edition, the author maintains a cohesive, comprehensive technology integration framework that builds on strong research and numerous integration strategies. This Technology Integration Framework achieves the following goals:

Introduces Your Students to Technology Integration

Technology Integration in Action ◄ examples, located at the beginning of Chapters 2 through 15, are classroom-based scenarios that provide a classroom context for chapter content by focusing on the selection and use of specific technology within a classroom environment. Each walks the reader through the steps of the Technology Integration Lesson Planning exercise (TIP) Model and is tied to chapter objectives.

Hot Topics for Debate ▼ help teachers address social issues that may present obstacles to effective technology integration.

Adapting for Special Needs ► features give your students alternative software and technology suggestions to consider for use in supporting students with special needs.



TECHNOLOGY INTEGRATION IN ACTION
SHARING A PASSION FOR POETRY

GRADE LEVEL: Grades 4–5 • CONTENT AREA/TOPIC: Language arts, poetry • LENGTH OF TIME: An hour each day for 6 days

PHASE 1 ANALYSIS OF LEARNING AND TEACHING NEEDS

Step 1: Determine relative advantage.

Step 2: Assess required resources and skills.

PHASE 2 PLANNING FOR INTEGRATION

Step 3: Decide on objectives and assessments.

Step 4: Design integration strategies.

Hot Topic Debate
Can Students Learn as Well Online as Face-to-Face?

Adapting for Special Needs

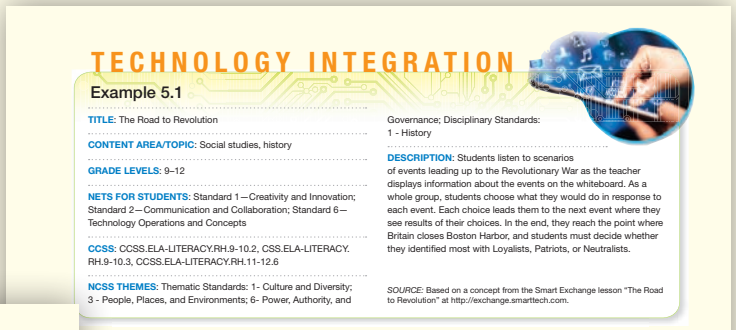
Software Tools

USING DATA COLLECTION AND ANALYSIS TOOLS

Database Software

Helps Your Students Plan for Effective Technology Integration

Technology Integration Examples (TIEs) ► located in Chapters 3 through 15 offer numerous technology lesson ideas that can be incorporated into lesson planning across the curriculum. Each lesson suggestion is correlated to the ISTE National Educational Technology Standards for Students (ISTE Standards•S) and Common Core State Standards.



TECHNOLOGY INTEGRATION

Example 5.1

TITLE: The Road to Revolution

CONTENT AREA/TOPIC: Social studies, history

GRADE LEVELS: 9–12

NETS FOR STUDENTS: Standard 1—Creativity and Innovation; Standard 2—Communication and Collaboration; Standard 6—Technology Operations and Concepts

CCSS: CCSS.ELA-LITERACY.RH.9-10.2, CSS.ELA-LITERACY.RH.9-10.3, CCSS.ELA-LITERACY.RH.11-12.6

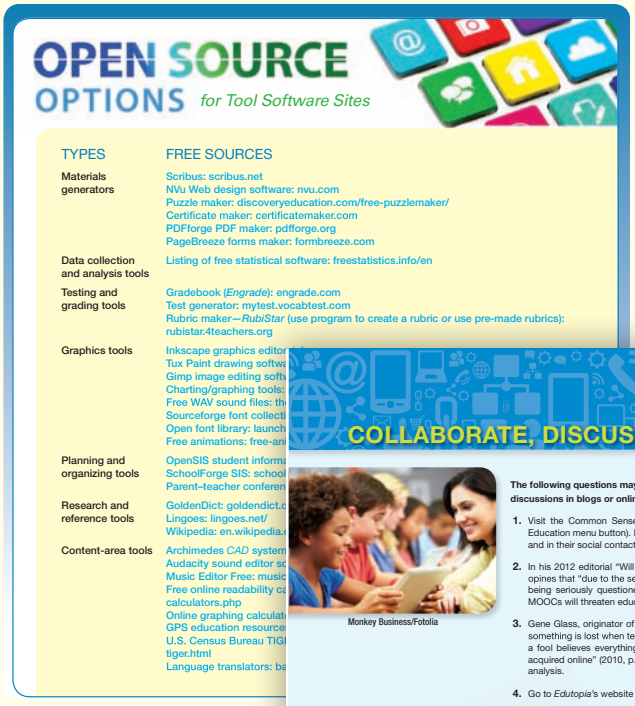
NCSS THEMES: Thematic Standards: 1- Culture and Diversity; 3 - People, Places, and Environments; 6- Power, Authority, and Governance; Disciplinary Standards: 1 - History

DESCRIPTION: Students listen to scenarios of events leading up to the Revolutionary War as the teacher displays information about the events on the whiteboard. As a whole group, students choose what they would do in response to each event. Each choice leads them to the next event where they see results of their choices. In the end, they reach the point where Britain closes Boston Harbor, and students must decide whether they identified most with Loyalists, Patriots, or Neutralists.

SOURCE: Based on a concept from the Smart Exchange lesson "The Road to Revolution" at http://exchange.smarttech.com.

USING MATERIALS GENERATORS

Materials generators include desktop publishing software, Web page editors, whiteboard activity software, worksheet and puzzle generators, IEP generators, graphic document makers, and PDF and forms makers. A summary of these, with sample products and classroom uses, is shown in Table 5.2. Also see here a summary of free software tools in Open Source Options.



OPEN SOURCE OPTIONS *for Tool Software Sites*

TYPES	FREE SOURCES
Materials generators	Scribus: scribus.net NVu Web design software: nvu.com Puzzle maker: discoveryeducation.com/free-puzzlemaker/ Certificate maker: certificatemaker.com PDFforge PDF maker: pdfforge.org PageBreeze forms maker: formbreeze.com
Data collection and analysis tools	Listing of free statistical software: freestatistics.info/en
Testing and grading tools	Gradebook (*Engrade*): engrade.com Test generator: mytest.vocabtest.com Rubric maker—*RubiStar* (use program to create a rubric or use pre-made rubrics): rubistar.4teachers.org
Graphics tools	Inkscape graphics editor Tux Paint drawing softwa Gimp image editing soft Charting/graphing tools: Free WAV sound files: th Sourceforge font collecti Open font library: launch Free animations: free-ani
Planning and organizing tools	OpenSIS student informa SchoolForge SIS: school Parent–teacher conferen
Research and reference tools	GoldenDict: goldendict.c Lingoes: lingoes.net/ Wikipedia: en.wikipedia.(
Content-area tools	Archimedes *CAD* system Audacity sound editor sc Music Editor Free: music Free online readability ca calculators.php Online graphing calculat GPS education resource U.S. Census Bureau TIGI tiger.html Language translators: ba

CHAPTER 5 | Technol

serve as blueprints for each special student's instructional activities, and teachers must provide documentation that such a plan is on file and that it governs classroom activities. **IEP generator** software assists teachers in preparing IEPs (Wilson, Michaels, & Margolis, 2005). Like test and worksheet generators, IEP generators provide on-screen prompts that remind users of the required components in the plan. When a teacher finishes entering all the necessary information, the program prints out the IEP in a standard format. Some IEP generation programs also accept data updates on each student's progress. See also the Adapting for Special Needs feature.

Graphic Document Makers

Graphic document makers are software tools that simplify the activity of making highly graphic materials, such as awards certificates and greeting cards. They offer sets of clip art and predesigned templates to which teachers and students can add their own content. For example, teachers have found certificates to be a useful kind of recognition. Certificates congratulate students for accomplishments, and the students can take them home and share them with parents and friends. Most certificate makers include numerous templates for various kinds of achievements, a feature that makes teachers prefer them over word processing software for these kinds of tasks. You can select the template that is appropriate for the kind of recognition intended (e.g., completing an activity, being a first-place winner) and enter the personal information for each recipient. Also, students frequently find it motivating to use these packages to design their own certificates, cards, and flyers. The most popular of these document makers is Printshop (Broderbund). This and similar software tools are listed in Table 5.2. Though graphic document makers are still being used, word processing and drawing software packages now offer many of the same advantages, including a variety of templates for various awards.

PDF and Forms Makers

Portable Document Format (PDF) file software, created by Adobe, permits the viewing and sending of documents as images. Since they are viewed as images, the PDF document displays all of the formatting and design elements (e.g., margins, graphics) of the original document without requiring access to the software used to create it. Adobe Acrobat Pro or a similar program is used to create these files, but Adobe also provides free software to read documents saved in PDF for- is often used in conjunction with **forms makers** such as PDF reates documents and Web pages with forms that can be filled makers useful because they make it easier to create forms to

COLLABORATE, DISCUSS, REFLECT

Monkey Business/Fotolia

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

1. Visit the Common Sense Media website and review its Digital Citizenship Curriculum (under the Education menu button). How could a grasp of these skills and attitudes help young people in learning and in their social contacts with other students?
2. In his 2012 editorial "Will MOOCs Destroy Academia?" from the *Communications of the ACM*, Vardi opines that "due to the seductive possibilities of lower costs . . . the very value of college education is being seriously questioned" (p. 5). What evidence can you cite to support or refute the idea that MOOCs will threaten education as we know it? Will it have any impact on K–12 schools?
3. Gene Glass, originator of meta-analysis techniques, said, "Experienced education leaders worry that something is lost when teachers are replaced by avatars and real life is replaced by Facebook . . . only a fool believes everything that can be gained from face-to-face teaching and learning also can be acquired online" (2010, p. 34). Give examples from research and practice to support or refute Glass's analysis.
4. Go to *Edutopia*'s website and do the following two activities:
   a. In *Edutopia*'s "Technology Integration Research Review" from February 5, 2013, there is evidence summarizing the impact of educational technologies; learn what research can teach us about effective uses of technology for learning. Read especially the studies by subject area, such as science or writing. Summarize what you learned about the overall benefits of technology-based strategies and of using technology to teach your subject.
   b. Also at the *Edutopia* website, click on the Video tab to access the video collection. In the Search by Topic window, use the menu to browse videos by topic, and select Technology Integration. Watch one of the videos. (i) Which of the perspectives that shaped educational technology is evident in the video? (ii) Refer to Figure 1.7 in the text, and list elements that show which reasons the technology in the video is being used.
5. Educational technology historian Paul Saettler (1990) said, "Computer information systems are not just objective recording devices. They also reflect concepts, hopes, beliefs, attitudes" (p. 539). Contrast the concepts, hopes, beliefs, and attitudes that our past versus current uses of technology in education reflect.
6. Richard Clark's now-famous comment about the impact of computers on learning was that the best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in our nutrition (Clark, 1983, p. 445). Why has this statement had such a dramatic (and, in some cases, emotional) impact on educational technology practitioners? What evidence could you cite to respond to it?
7. In their study of students' reasons for online plagiarism, Comas-Forgas and Sureda-Negre (2010) found that some students say it "is easier, simpler and more comfortable than doing the work yourself" (p. 223). Can you suggest arguments that would help persuade students that online plagiarism, while easy and quick, is not in their best interests?

Chapter 1 Summary

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

1. **Introduction: The "Big Picture" on Technology in Education**
   - This chapter's "big picture" review provides an important framework for viewing the field and consists of key terminology, reflections on the past, considerations about the present, and a look ahead to the future.
   - Four perspectives help define today's educational technology: educational technology as communications media (originally represented by AECT); educational technology as instructional systems and instructional design (originally represented by ISPI); educational technology as vocational training

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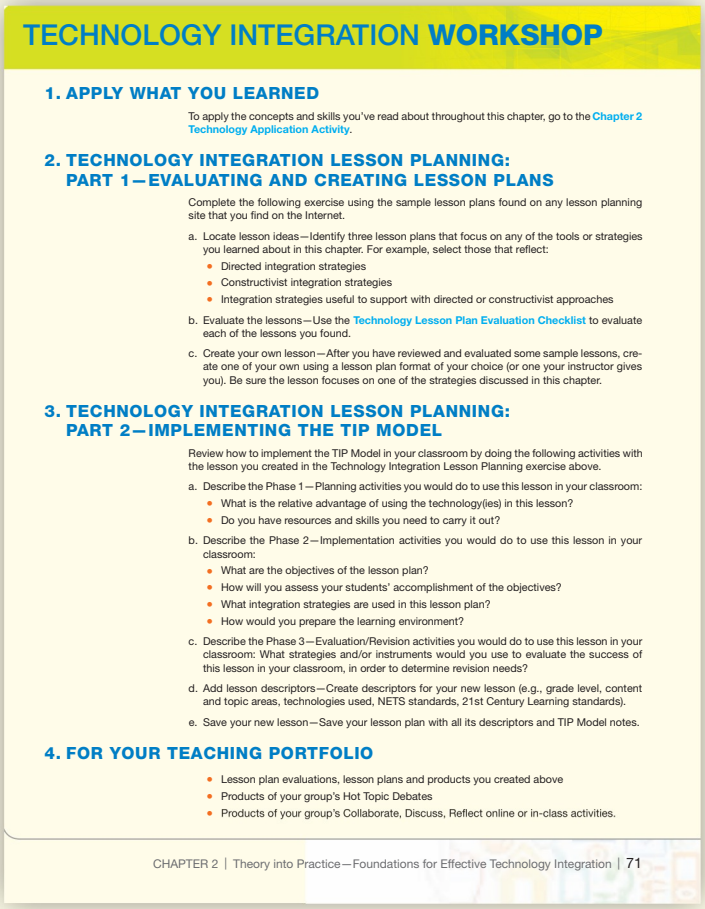
▲ Open Source Options are free resources that help teachers stretch their limited budgets for educational materials.

◄ Collaborate, Discuss, Reflect features provide students with questions they can use either for in-class, small-group discussions or to initiate discussions in blogs or online discussion boards.

◄ Summaries at the end of each chapter tie back to the learning outcomes and act as study aids by summarizing and reviewing critical chapter content.

Helps Your Students Practice Technology Integration



TECHNOLOGY INTEGRATION **WORKSHOP**

1. APPLY WHAT YOU LEARNED

To apply the concepts and skills you've read about throughout this chapter, go to the Chapter 2 Technology Application Activity.

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

Complete the following exercise using the sample lesson plans found on any lesson planning site that you find on the Internet.

a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example, select those that reflect:
- Directed integration strategies
- Constructivist integration strategies
- Integration strategies useful to support with directed or constructivist approaches

b. Evaluate the lessons—Use the Technology Lesson Plan Evaluation Checklist to evaluate each of the lessons you found.

c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the strategies discussed in this chapter.

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

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

a. Describe the Phase 1—Planning activities you would do to use this lesson in your classroom:
- What is the relative advantage of using the technology(ies) in this lesson?
- Do you have resources and skills you need to carry it out?

b. Describe the Phase 2—Implementation activities you would do to use this lesson in your classroom:
- What are the objectives of the lesson plan?
- How will you assess your students' accomplishment of the objectives?
- What integration strategies are used in this lesson plan?
- How would you prepare the learning environment?

c. Describe the Phase 3—Evaluation/Revision activities you would do to use this lesson in your classroom: What strategies and/or instruments would you use to evaluate the success of this lesson in your classroom, in order to determine revision needs?

d. Add lesson descriptors—Create descriptors for your new lesson (e.g., grade level, content and topic areas, technologies used, NETS standards, 21st Century Learning standards).

e. Save your new lesson—Save your lesson plan with all its descriptors and TIP Model notes.

4. FOR YOUR TEACHING PORTFOLIO
- Lesson plan evaluations, lesson plans and products you created above
- Products of your group's Hot Topic Debates
- Products of your group's Collaborate, Discuss, Reflect online or in-class activities.

CHAPTER 2 | Theory into Practice—Foundations for Effective Technology Integration | 71

◀ **A Technology Integration Workshop**, located at the end of every chapter, includes hands-on, interactive activities that connect chapter content to real-life practice. Each Workshop contains the following:

- **Technology Integration Lesson Planning** exercises, which provide students the opportunity and resources to evaluate a set of technology integration lessons and to modify or create their own lesson plans to meet their classroom needs.
- **An Implementing the TIP Model** activity, which asks teachers to show how they would implement the TIP Model in their classrooms by doing activities with the lesson(s) they created in the Technology Integration Lesson Planning exercise.
- **For Your Teaching Portfolio** feature, which directs students to save the material they created in each chapter in a personal portfolio.

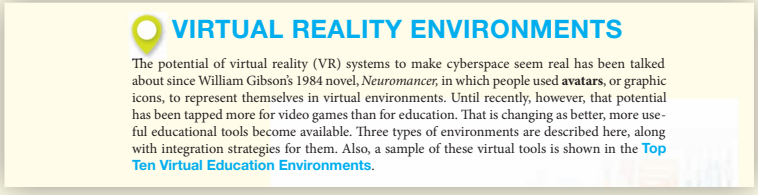
NEW INTERACTIVE ETEXT FEATURES!

An all-new Pearson eText version includes the following interactive features in each chapter:

Author-recorded BIG IDEAS OVERVIEW (BIO) on main chapter concepts and points to guide reading. ▶

CHAPTER 4 **BIG IDEAS OVERVIEW**

Before you begin reading the rest of this chapter, listen to the Chapter 4 Big Ideas Overview. It will give you a two-minute audio overview of main concepts to look for and help prepare you to work through information and exercises to achieve this chapter's outcomes.

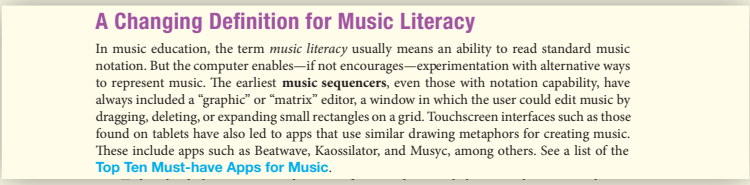


VIRTUAL REALITY ENVIRONMENTS

The potential of virtual reality (VR) systems to make cyberspace seem real has been talked about since William Gibson's 1984 novel, *Neuromancer,* in which people used **avatars**, or graphic icons, to represent themselves in virtual environments. Until recently, however, that potential has been tapped more for video games than for education. That is changing as better, more useful educational tools become available. Three types of environments are described here, along with integration strategies for them. Also, a sample of these virtual tools is shown in the Top Ten Virtual Education Environments.

◀ **Top Ten** (in Chapters 1, 3–8) pop up features highlight and describe the best software features, uses, and strategies for teachers to apply.

Top Ten Must-Have Apps (in Chapters 9–15) present apps that are widely used in society, and examples help educators see the role these tools are beginning to play in education. ▶

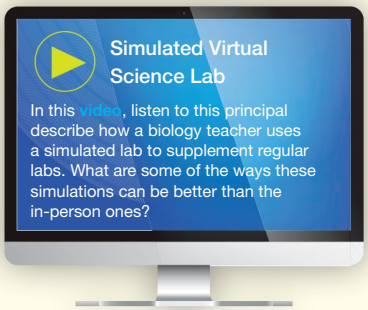


A Changing Definition for Music Literacy

In music education, the term *music literacy* usually means an ability to read standard music notation. But the computer enables—if not encourages—experimentation with alternative ways to represent music. The earliest **music sequencers**, even those with notation capability, have always included a "graphic" or "matrix" editor, a window in which the user could edit music by dragging, deleting, or expanding small rectangles on a grid. Touchscreen interfaces such as those found on tablets have also led to apps that use similar drawing metaphors for creating music. These include apps such as Beatwave, Kaossilator, and Musyc, among others. See a list of the Top Ten Must-have Apps for Music.

Interactive Technology Learning Checks (TLCs) at the end of each major section matched to each chapter learning outcome. These help readers apply the concepts and ensure that they master each chapter outcome. ►

TECHNOLOGY LEARNING CHECK
Complete **TLC 2.5** to review what you have learned from reading this section about technology integration strategies based on both models.



◄ **Links to video** illustrations and commentaries from practitioners in the field.

End-of-chapter Technology Integration Workshops now include: **Technology Application Activities and Technology Lesson Plan Evaluation Checklists** ►

TECHNOLOGY INTEGRATION **WORKSHOP**

1. APPLY WHAT YOU LEARNED

To apply the concepts and skills you've read about throughout this chapter, go to the **Chapter 7 Technology Application Activity**.

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

Complete the following exercise using the sample lesson plans found on any lesson planning site that you find on the Internet.

a. Locate lesson ideas—Identify three lesson plans that focus on any of the tools or strategies you learned about in this chapter. For example:
- Web-based lessons and projects
- Podcasts and vodcasts
- Flipped classroom and other blended models

b. Evaluate the lessons—Use the **Technology Lesson Plan Evaluation Checklist** to evaluate each of the lessons you found.

c. Create your own lesson—After you have reviewed and evaluated some sample lessons, create one of your own using a lesson plan format of your choice (or one your instructor gives you). Be sure the lesson focuses on one of the technologies or strategies discussed in this chapter.

SUPPORT MATERIALS FOR INSTRUCTORS

The following resources are available for instructors to download on www.pearsonhighered.com/educators. Instructors enter the author or title of this book, select this particular edition of the book, and then click on the "Resources" tab to log in and download textbook supplements.

Instructor's Resource Manual and Test Bank (0133955389)

The *Instructor's Resource Manual and Test Bank* includes a wealth of interesting ideas and activities designed to help instructors teach the course. Each chapter contains learning outcomes, key terms, key concepts, and group activities, as well as a comprehensive test bank containing multiple choice, short answer and essay questions.

PowerPoint Slides (0133971988)

Designed for teachers using the text, the *PowerPoint™ Presentation* consists of a series of slides that can be shown as is or used to make handouts or overhead transparencies. The presentation highlights key concepts and major topics for each chapter.

TestGen (0133944859)

TestGen is a powerful test generator available exclusively from Pearson Education publishers. You install TestGen on your personal computer (Windows or Macintosh) and create your own tests for classroom testing and for other specialized delivery options, such as over a local area network or on the web. A test bank, which is also called a Test Item File (TIF), typically contains a large set of test items, organized by chapter and ready for your use in creating a test, based on the associated textbook material.

The tests can be downloaded in the following formats:

- TestGen Testbank file—PC
- TestGen Testbank file—MAC
- TestGen Testbank—Blackboard 9 TIF
- TestGen Testbank—Blackboard CE/Vista (WebCT) TIF
- Angel Test Bank (zip)
- D2L Test Bank (zip)
- Moodle Test Bank
- Sakai Test Bank (zip)

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Both the goal and challenge of this book have been to provide the reader with the most up-to-date, yet foundational, theory, research, and practices in educational technology across the disciplines. I believe this goal has been achieved. As in any project, realizing this goal would not have been possible without the assistance of numerous individuals who helped sharpen the focus of this edition. These individuals include the reviewers for this edition: Li-Ling Chen, California State University at East Bay; Mary Jo Dondlinger, Texas A&M University, Commerce; Lynne M. Pachnowski, University of Akron; Karen M. McFerrin, Ed.D., Northwestern State University; Kevin Oliver, North Carolina State University.

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Chapter 9
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Chapter 15
Teaching and Learning with Technology in Special Education and Adapting for Special Needs features

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—M. D. Roblyer

1 Educational Technology in Context

THE BIG PICTURE

Learning Outcomes

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

1. Analyze how the following work together to shape today's educational technology events and trends in schools: (a) different groups' historical perspectives on educational technology; and (b) current definitions for educational technology, instructional technology, and integrating educational technology. (ISTE Standards•T 5)
2. Identify periods in the history of digital technologies, and describe what we have learned from this history that can help us use educational technology effectively today. (ISTE Standards•T 5)
3. Place a given educational technology resource in one of the general hardware categories (microcomputer, handheld, display, imaging, peripheral, or external storage), software categories (instructional, productivity, and administrative), or media (e.g., flash drive, CD, DVD). (ISTE Standards•T 4, 5)
4. Identify and analyze the impact of societal, educational, cultural/equity, and legal/ethical issues on current uses of technology in education. (ISTE Standards•T 4, 5)
5. Identify examples of technology literacy and other 21st-century skills that teachers and their students need in order to be prepared for future learning and the world of work, and select a teaching portfolio format from available technology-based platforms to document your accomplishment of these skills and Tech-PACK growth. (ISTE Standards•T 5)
6. Generate a personal rationale for using technology in teaching based on research findings, popular teaching practices, and types of problems that technology applications can solve. (ISTE Standards•T 5)
7. Identify trends in emerging technologies and describe how they shape trends in teaching and learning. (ISTE Standards•T 5)

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TECHNOLOGY INTEGRATION IN ACTION: THEN AND NOW

THEN . . .

Anna was almost as proud of her new classroom computers as she was of her new teaching degree. She had high hopes for the 1980–1981 school year in her first teaching position, especially since the principal had asked her if she could use two brand-new Apple computer systems that had been donated to the school. As a student teacher, she had helped children use **computer-assisted instruction (CAI)** on terminals that were located in the school's computer lab and connected by telephone lines to her university's big mainframe computer, but this would be much different. Now the computers would be located right in her classroom, and how she used them would be completely up to her. With her new skills and these marvelous devices at her disposal, she felt a heady sense of power and anticipation.

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

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

NOW . . .

As she prepared to begin another school year, Anna found it difficult to believe it had been over 35 years since that first pioneering work with her Apple microcomputers. This school year, she had received a set of tablet computers, part of the district's one child-one computer initiative, and an **interactive whiteboard**, a device that would allow her to project information from a computer to a screen and then manipulate it either with special pens or hands. The school district had offered these tools to any teachers who proposed innovative ways to engage girls and minority students in math and science projects. With these devices, it would be so much easier for her students to access online math manipulatives and science simulations and collaborate with students in other locations. Her class's favorite activity this year was working with students around the state to gather and compare data on local environmental conditions, but they also liked the spreadsheet software's "Buy a Car" activity.

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

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

Yet despite these concerns, Anna was amazed at how far educational technology had come from those first, hesitant steps in the classroom, and how much more there still was to try. She knew other teachers her age who had retired, but she was too interested in what she was doing to think about that. She was helping with a virtual program for homebound students and leading a funded project to develop curricula for the district's social media. Not a day went by that a teacher didn't come to her for help with a new project. She couldn't wait to see what challenges lay ahead. She looked forward to the future.

CHAPTER 1 BIG IDEAS OVERVIEW

Before you begin reading the rest of this chapter, listen to the **Chapter 1 Big Ideas Overview**. It will give you a two-minute audio overview of main concepts to look for and help prepare you to work through information and exercises to achieve this chapter's outcomes.

INTRODUCTION: THE "BIG PICTURE" ON TECHNOLOGY IN EDUCATION

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

Why We Need the "Big Picture"

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

- **Key terminology**. Talking about a topic requires knowing the vocabulary relevant to that topic. Educators who want to study the field must recognize that language used to describe technology reflects differing perspectives on the appropriate uses of educational technology.
- **Reflecting on the past**. Showing where the field began helps us understand where it is headed and why. Reflecting on changes in goals and methods in the field over time casts new light on the challenges and opportunities of today's technologies.
- **Considering the present**. The current role of educational technology is shaped primarily by two factors: available technology resources and our perspectives on how to use them. Available technologies dictate what is possible; a combination of social, instructional, cultural, and legal issues influence the directions we choose to take.
- **Looking ahead to the future**. Technology resources and societal conditions change so rapidly that today's choices are always influenced as much by emerging trends as by current conditions. To be informed citizens of an information society, teachers must be futurists.

Perspectives That Define Educational Technology

Saettler (1990) says that the earliest references to the term *educational technology* were by radio instruction pioneer W. W. Charters in 1948, and *instructional technology* was first used by audiovisual expert James Finn in 1963. Even in those early days, definitions of these terms focused on more than just devices and materials. Saettler notes that the 1970 Commission on

Instructional Technology defined educational technology as both "the media born of the communication revolution which can be used for instructional purposes" (p. 6) and "a systematic way of designing, carrying out, and evaluating the total process of learning and teaching" (p. 6). As the 1970 commission concluded, a broader definition of educational technology that encompasses both tools and processes "belongs to the future" (Saettler, 1990, p. 6).

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

Perspective #1: Educational technology as communications media.

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

Perspective #2: Educational technology as instructional systems and instructional design.

This view originated with post–World War II military and industrial trainers who were faced with preparing large numbers of personnel quickly. Based on efficiency studies and learning theories from educational psychology, they advocated using more planned, systematic approaches to developing uniform, effective materials and training procedures. Their view was based on the belief that both human (teachers) and nonhuman (media) resources could be part of an efficient system for addressing any instructional need. Therefore, they equated "educational technology" with "educational problem solutions." This perspective has evolved into **human performance technology** or a systematic approach to improving human productivity and competence by using strategies for solving problems.

Perspective #3: Educational technology as vocational training.

Also known as **technology education**, this perspective originated with industry trainers and vocational educators in the 1980s. They believed (1) that an important function of school learning

TABLE 1.1 Organizations with Various Perspectives on Technology in Education

Association for Educational Communications and Technology (AECT)	International Technology and Engineering Educators Association (ITEEA)	International Society for Performance Improvement (ISPI)	International Society for Technology in Education (ISTE)
Perspectives on Technology in Education and Training			
Initial focus: Audio-visual (AV) devices and media	*Initial focus:* Manufacturing and materials skills	*Initial focus:* Information concerned with programmed instruction	*Initial focus:* Computer systems
Now: Using any resources to improve teaching and learning	*Now:* STEM education and careers	*Now:* Improving human performance	*Now:* Digital devices and systems
Current Definitions for Technology in Education/Training			
Educational technology is facilitating learning and improving performance by creating and using technological processes and resources.	*Technology education* is problem-based learning using STEM principles.	*Human performance technology* is a systematic approach to improving productivity and competence.	*Educational technology* is the full range of digital hardware used to support teaching and learning.

is to prepare students for the world of work in which they will use technology, and (2) that vocational training can be a practical means of teaching all content areas, such as math, science, and language. This view brought about a major paradigm shift in vocational training in K–12 schools away from industrial arts curricula centered in woodworking/metals and graphics/printing shops and toward technology education courses taught in labs equipped with technology stations, such as graphics production, robotics systems, and **computer-aided design (CAD) software**, a program used by architects and others to aid in the design of structures such as houses and cars.

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

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

How This Textbook Defines Technology in Education

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

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

FIGURE 1.1 A Framework for Viewing Educational Technology

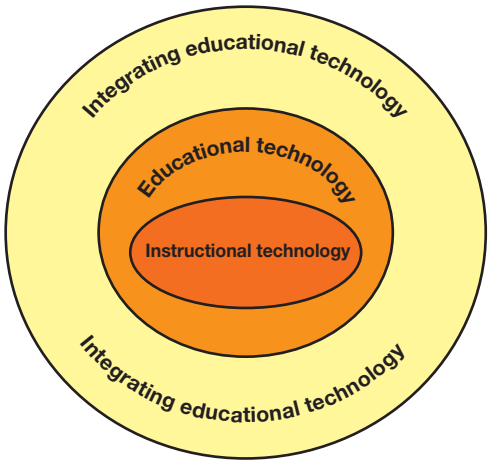

Figure 1.1 shows the framework in which to view these tools and processes. The terms shown in this figure have the following "evolving" definitions:

- **Educational technology** is a combination of the *processes* and *tools* involved in addressing educational needs and problems, with an emphasis on applying the most current digital and information tools.
- **Integrating educational technology** refers to the process of *matching digital tools and methods* to given educational needs and problems.
- **Instructional technology** is the *subset of educational technology* that deals directly with teaching and learning applications (rather than educational administrative ones).

TECHNOLOGY LEARNING CHECK

Complete **TLC 1.1** to review what you have learned from reading this section about basic perspectives and definitions underlying technology integration.

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

Though a "technology" can be anything from a pencil to a virtual environment, the modern history of technology in education has been shaped in large part by developments in digital technologies, such as computers. The four eras in the history of digital technologies, shown in Figure 1.2, are described in this section, followed by a summary of what we have learned from the past that can help us become more effective technology users today.

FIGURE 1.2 Digital Technologies in Education: A Timeline of Events That Shaped the Field

PRE-MICROCOMPUTER ERA

1950
First computers used for instruction: Computer-driven flight simulator trains MIT pilots

© U.S. Air Force

1959
First computer used with school children: IBM 650 teaches binary arithmetic in NYC

Studio 8/Pearson Education

1960s
University time-sharing movement: Mainframes used for programming and shared utilities

Eimantas Buzas/ Shutterstock

Early 1970s
Computer-assisted instruction (CAI) movement: Schools use university-based mainframes/mini-computers

Weerapat1003/Fotolia

Mid-to-late 1970s
Schools begin using computers for instruction and administration: CDC's announces PLATO system

Courtesy of Wikipedia

Late 1970s
Arthur Luehrmann coins term *computer literacy*; Andrew Molnar warns: non-computer-literate students are at risk

John Foxx Collection/ Imagestate

MICROCOMPUTER ERA

1977
Microcomputers enter schools. Teachers begin to control instructional applications.

Pearson Education

1980s
Microcomputer movements: software publishing, teacher authoring, Logo problem solving

4tomania/Fotolia

1980s–early 1990s
ILS marks movement to networks, away from desktop systems

Monkey Business/Fotolia

INTERNET ERA

1993
World Wide Web born: First browser (Mosaic) transforms Internet. Teachers enter Information Superhighway

MaverickLEE/Shutterstock

1994
Internet use explodes; distance learning increases in higher education

MonkeyBusiness/Fotolia

1995
Virtual schooling (online courses in high school) begins

Sophie Bluy/Pearson Education

MOBILE TECHNOLOGIES, SOCIAL MEDIA, AND OPEN ACCESS ERA

2001
Wikipedia begins; crowdsourcing movement gains momentum

Arahan/Fotolia

2005
Social networking sites such as Facebook are established

© Shutterstock

2006
Twitter established; social media enter classrooms

Hackerkuper/Fotolia

2007
Amazon releases first Kindle ebook reader)

© Shutterstock

2010
Apple releases first iPad (handheld computer)

Photo by W. Wiencke.

2010–2020
Mobile technologies spawn BYOD/BYOT movements; MOOCs offer schools new access possibilities

Image 100/Corbis/Glow Images

Era 1: The Pre-Microcomputer Era

Many of today's teachers began using computer systems only since microcomputers came into common use, but a thriving educational computing culture predated microcomputers by 20 years. The first computers were used instructionally as early as the 1950s. In the late 1960s, IBM pioneered the IBM 1500, the first instructional **mainframe**, or large-scale computer with many users connected to it with terminals. On the IBM 1500, these terminals were **multimedia learning stations** capable of displaying animation and video. By the time IBM discontinued it in 1975, some 25 universities were using this system to develop **computer-assisted instruction (CAI)** materials that schools used via long-distance connections. CAI was software designed to help teach information and/or skills related to a topic. The most prominent of these efforts was led by Stanford University professor and "Grandfather of CAI" Patrick Suppes, who developed the Coursewriter programming language to create reading and mathematics lessons. Companies such as the Computer Curriculum Corporation (CCC, founded by Suppes) and the Programmed Logic for Automatic Teaching Operations (PLATO) system (developed by the Control Data Corporation) dominated the field for about 15 years. Universities also developed CAI for these large-scale computers, as well as **computer-managed instruction (CMI)** applications, or programs that kept track of students' performance data based on mastery learning models. Even after smaller **minicomputer** systems, then a designation for systems smaller that mainframes that could support fewer users at a time, replaced mainframes to deliver CAI and CMI to schools, systems were expensive to buy and complex to operate and maintain, so school district offices controlled their purchase and use. But by the late 1970s, it was apparent that there was little support for computer-based curriculum controlled by district data processing and industry personnel; schools began to reject the business office model of using computers to revolutionize instruction.

Era 2: The Microcomputer Era

Integrated circuits made computers both smaller and more portable beginning in 1975, and teachers began to bring small, stand-alone, desktop computers called **microcomputers**, or systems designed for use by only one person at a time, into their classrooms. This grassroots movement wrested control of educational computers from companies, universities, and school districts and placed them directly into the hands of teachers and schools. Several initiatives emerged to shape this new teacher-centered control: a software publishing movement that catered to teachers quickly sprang up; organizations emerged to review software and help teachers select quality products; and professional organizations, journals, and magazines began to publish software reviews and recommend "top products." Teachers clamored for more input into courseware design, so companies created authoring languages and systems (e.g., PILOT, SuperPILOT, GENIS, PASS). However, teacher authoring soon proved too time consuming, and interest faded. As schools searched for a way to make CAI more cost effective, districts began to purchase networked **integrated learning systems (ILSs)**, or networked systems that provide both CAI-based curriculum and CMI functions, to help teachers address required standards. Control of instructional computer resources moved once again to central servers in school district offices. Three other technology initiatives also became prominent in this era:

- **The computer literacy movement**. When author and researcher Arthur Luehrmann coined the term **computer literacy** to mean required levels of skills in using the computer, schools tried to implement computer literacy curriculum. However, these efforts were eventually dropped due to difficulties in defining and measuring skills.
- **Videodisc-based curriculum**. Companies such as ABC News and the Optical Data Corporation joined forces to offer curriculum on videodiscs, both standalone (level 1) and connected to microcomputers (level 3). But, when other forms of optical and digital storage replaced videodisc technology, curricula were not transferred.
- **The Logo movement**. A final focus during this period was teaching **Logo** programming, a high-level language originally designed as an **artificial intelligence (AI)** language designed to emulate decision-making capabilities of the human mind, but used by Seymour Papert (1980) to support his view that computers should be used as an aid to teach problem solving.

Logo began to replace CAI as the "best use" of computer technology. Despite its popularity and research showing it could be useful in some contexts, researchers could capture no Logo impact on mathematics or other curriculum skills, and interest in Logo, too, waned by the beginning of the 1990s.

Era 3: The Internet Era

At the beginning of the 1990s, the **Internet**, a worldwide collection of university computer networks that could exchange information by using a common software standard had already been operating for many years. Then the **World Wide Web** was introduced in 1993. This was a system within the Internet that allowed graphic displays of Internet sites through hypertext links, or pieces of texts or images that allowed users to jump to other locations connected by the links. The first **browser** software (*Mosaic*) designed especially to allow users to use these links marked the beginning of the third era of educational technology. Teachers and students joined the throng of users on the "Information Superhighway," and interest in computer technology's potential for instruction once again sprang to life. By the beginning of the 2000s, email, online (i.e., Web-based) multimedia, and videoconferencing became standard tools of Internet users. Websites became a primary form of communication for educators, and distance education became a more prominent part of instructional delivery at all levels of education. The meaning of "online" changed from simply being on the computer to being connected to the Internet. **Virtual schools**, or schools in which "(K–12) students and teachers are separated by time and/or location and interact via computers and/or telecommunications technologies" (National Forum on Education Statistics, 2006, p. 1) began a steady growth that would see it become a mainstay of public education in the 2000s.

Era 4: The Mobile Technologies, Social Media, and Open Access Era

The current era began the early 2000s, when portable devices such as smartphones and tablets made Internet access and computer power ubiquitous. As more and more individuals made texting and social networking sites like Facebook and Twitter part of their everyday lives, this constant connectedness transformed educational practice. The ease of access to online resources and communications drove several movements.

- **Distance learning**. A dramatic increase in the number and type of distance learning offerings came about, first in higher education and then in K–12 schools.
- **Electronic books** (**e-books** or **e-texts**). Texts in digital form on computers, e-book readers, and cell phones became increasingly popular alternatives to printed texts. Some school districts eschewed book adoptions in favor of allowing educators to choose their own digital materials.
- **Mobile access**. One-to-one laptop programs (and later tablet programs), as well as **Bring Your Own Device (or Technology, BYOD or BYOT) programs** were those that allowed students to use their own handheld devices for learning and accelerated the move to bring computer and Internet access into all classrooms. Another type of access that may be on the horizon is what some educators are calling **1:X Computing** or "one to many computing." This is when students have access to many different digital devices from which they may choose "depending on the task at hand" (Herold, 2013, p. s2).
- **Open access**. Around 2008, open-access university offerings called **Massive Open Online Courses (MOOCs)**, which allowed anyone anywhere in the world to participate in college courses for free, became available. By 2011, MOOC projects at MIT, Harvard, and Stanford popularized the concept, and MOOCs came into common use in other colleges and universities. The later part of the decade would see the MOOC concept evolve, as higher education began charging fees for MOOC credit.

As ubiquitous communications and social networking defined social practices in modern life, educators struggled to create appropriate policies and uses that could take advantage of this new power while minimizing its risks and problems.

What We Have Learned from the Past

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

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

Teachers usually do not develop technology materials or curriculum. In the microcomputer era, companies tried to market authoring systems so teachers could create their own materials, but such systems were never widely adopted. Teaching is one of the most time- and labor-intensive jobs in our society. With so many demands on their time, most teachers cannot be expected to develop software or create complex technology-based teaching materials. Publishers, school or district developers, or personnel in funded projects have traditionally provided the majority of this assistance; this seems unlikely to change in the future, even for distance education courses or digital instructional materials.

"Technically possible" does not equal "desirable, feasible, or inevitable." A popular saying is that today's technology is yesterday's science fiction. But science fiction also shows us that technology brings undesirable—as well as desirable—changes. For example, greater access to cell phones and tablets in classrooms means that online communications and information are increasingly available. But as recent events have shown, communications always come with caveats, and readily available information is not always reliable or helpful. New technological horizons make it clear that it is time to analyze carefully the implications of each implementation decision. Better technology demands that we become critical consumers of its power and capability. We are responsible for deciding just which science fiction becomes reality.

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

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

Teachers always will be more important than technology. The developers of the first instructional computer systems in the 1960s foresaw them replacing many teacher positions; some advocates of today's distance learning methods envision a similar impact on