Updated to align with the 2017 ISTE Standards for Educators

3RD EDITION

Technology Integration for Meaningful Classroom Use

A STANDARDS-BASED APPROACH

Katherine S. Cennamo
John D. Ross
Peggy A. Ertmer

International Society for Technology in Education Standards for Educators: Correlations with Chapter Content

ISTE Standards	Chapters Where Addressed
Empowered Professional	
1. Learner. Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning. Educators: **a.** Set professional learning goals to explore and apply pedagogical approaches made possible by technology and reflect on their e□ectiveness. **b.** Pursue professional interests by creating and actively participating in local and global learning networks. **c.** Stay current with research that supports improved student learning outcomes, including findings from the learning sciences.	Ch. 2
2. Leader. Educators seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning. Educators: **a.** Shape, advance and accelerate a shared vision for empowered learning with technology by engaging with education stakeholders. **b.** Advocate for equitable access to educational technology, digital content and learning opportunities to meet the diverse needs of all students. **c.** Model for colleagues the identification, exploration, evaluation, curation and adoption of new digital resources and tools for learning.	Ch. 12
3. **Citizen.** Educators inspire students to positively contribute to and responsibly participate in the digital world. Educators: **a.** Create experiences for learners to make positive, socially responsible contributions and exhibit empathetic behavior online that build relationships and community. **b.** Establish a learning culture that promotes curiosity and critical examination of online resources and fosters digital literacy and media fluency. **c.** Mentor students in the safe, legal and ethical practices with digital tools and the protection of intellectual rights and property. **d.** Model and promote management of personal data and digital identity and protect student data privacy.	Ch. 11
Learning Catalyst	
4. Collaborator. Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas and solve problems. Educators: **a.** Dedicate planning time to collaborate with colleagues to create authentic learning experiences that leverage technology. **b.** Collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues. **c.** Use collaborative tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and globally. **d.** Demonstrate cultural competency when communicating with students, parents and colleagues and interact with them as co-collaborators in student learning.	Ch. 10

(*continued in the back*)

3RD EDITION

Technology Integration for Meaningful Classroom Use

A STANDARDS-BASED APPROACH

Katherine S. Cennamo
Virginia Polytechnic Institute and State University

John D. Ross
Edvantia

Peggy A. Ertmer
Purdue University

CENGAGE

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

CENGAGE

Technology Integration for Meaningful Classroom Use: A Standards-Based Approach, **Third Edition**
Katherine S. Cennamo, John D. Ross, and Peggy A. Ertmer

Product Team Manager: Carolyn Henderson-Meier

Manager, Content Delivery: Andrea Wagner

Content Manager: Mary Ann Lidrbauch

Product Assistant: Megan Nauer

Senior Marketing Manager: Mark Linton

Digital Content Specialist: Justin Hein

Senior Designer: Helen Bruno

Senior Content Project Manager: Samen Iqbal

Manufacturing Planner: Doug Bertke

Intellectual Property Analyst: Jennifer Bowes

Intellectual Property Project Manager: Kellianne Besse

Production Service Project Manager: Lori Hazzard, MPS Limited

Compositor: MPS Limited

Copy Editor: Heather McElwain

Cover and Text Designer: Diane Beasley

Cover Images: Tablets at school—GettyImages.com/Óscar López Rogado; Teenage student using tablet at desk—iStockPhoto.com/tetma; Student solving problem at board—iStockPhoto.com/monkeybusinessimages; Elementary students watching teacher with digital tablet—GettyImages.com/Hero Images; Students using a laptop together—iStockPhoto.com/FatCamera

Library of Congress Control Number: 2017956489

Student Edition:
ISBN: 978-1-305-96057-2

Loose-leaf Edition:
ISBN: 978-1-305-96059-6

Cengage
20 Channel Center Street
Boston, MA 02210
USA

Cengage is a leading provider of customized learning solutions with employees residing in nearly 40 different countries and sales in more than 125 countries around the world. Find your local representative at **www.cengage.com.**

Cengage products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage platforms and services, visit **www.cengage.com.**

To register or access your online learning solution or purchase materials for your course, visit **www.cengagebrain.com.**

Printed in the United States of America
Print Number: 01 Print Year: 2019

To friends, family, co-authors and colleagues;
to teachers everywhere who devote
their lives to making learning meaningful for their
students; and to the teachers, coaches, and others
who contributed to the book—you make it all possible.

Brief Contents

Contents

Preface

This book is designed to help *all* educators become leaders in teaching and technology integration. That might sound a bit ambitious, but if you think about it, it's a goal that is really not so far out of reach. After interacting with so many exemplary technology-using educators in our classrooms and theirs, at workshops and conferences, and through face-to-face and online interactions, we are convinced that anyone with a passion for helping students learn *with* technology can succeed. Whether you are old or young, teach first grade or high school, specialize in art or science, have a variety of previous experiences in education or are just starting out, or whether you have access to many or just a few technology resources—none of these conditions guarantees or precludes you from joining this special group of exemplary educators. Rather, what it takes is a keen understanding of how to use technology to support student-driven learning in authentic contexts—which is what this book is about. Believing in the value of technology is a good place to start, but the more critical piece is what you believe about how students learn best. Technology is a tool—a powerful tool—that can connect you and your students to new places and new people, and which allows you to create things you couldn't create otherwise. Technology enables you to transform your student-centered beliefs into meaningful practice.

We know that the majority of you who are using this book are probably very familiar with the many digital technologies that pervade our personal and social lives. You may not even be able to remember a time when you didn't know how to use a computer or cell phone or one of the many other digital devices that we turn to daily. Those of us who did not grow up with these devices have watched in amazement as you and your peers so easily (and continuously) use numerous technology tools simultaneously to communicate with your friends, look up information on the Internet, "like" a new product on Facebook, and follow the latest happenings on Twitter, Snapchat, or other social media. However, what we have found in our own practice, and what our colleagues in the teacher preparation field have confirmed, is that although most prospective educators have these basic, or even advanced, technology skills, they are typically not as familiar with, or maybe haven't yet considered, how to use these same technologies to support student learning.

Even when students enter preservice education courses with basic computer skills, they face unique challenges to achieving technology-enabled teaching and learning. Technologies change at lightning speed, making it difficult to keep up to date. In addition, these rapid changes are coupled with evolving teaching and content standards that require you to demonstrate competencies in specific technology skills and to teach in ways that ensure your students master specific learning outcomes. In this book we take the stance that it is important to empower you to be self-directed learners. Having self-directed learning (SDL) skills will equip you to successfully navigate the constantly changing environment of technology integration better than learning a specific body of computer or technology content that will almost immediately become outdated. For this reason, we have chosen to use a standards-based approach—as opposed to a tool- or content-based approach—as our framework for developing, modeling, and teaching the skills and knowledge necessary for achieving technology-enabled teaching and learning throughout your career.

Organization

The textbook is divided into 12 chapters, which have all been completely updated to align with the 2017 ISTE Standards for Educators. The current ISTE standards, along with the previous NETS-T, serve as a road map for inspired teaching and learning, and are credited with creating a target of excellence relating to technology use by teachers. The earliest set of NETS-T defined what teachers needed to know and be able to do with the technology tools that were becoming prevalent in schools. The subsequent 2008 NETS-T Standards inspired teachers to be creative, innovative digital-age leaders who use technologies to help students learn and thrive in a digital world. The current set of ISTE Standards for Educators builds on these previous versions to reflect "an evolution in the teaching profession" and to "focus on the promise technology has for empowering learning" (ISTE, 2017, p. i). This textbook, then, is designed to help you translate those ideals and visions into practical student-driven classroom learning experiences through the authentic and meaningful use of technology.

Using the principles of SDL as our foundation, the text is designed to help you learn how to evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student-driven learning. You will learn to self-assess what you currently know about the technology or the learning requirements at hand, determine what you need to know, access resources to help you address specific instructional challenges, evaluate the validity of those resources in terms of what you know and what you need to know, and evaluate the extent to which the resources will meet your learning needs. As you expand your knowledge through the use of resources found in this book and beyond, you will learn to monitor the effectiveness of your learning and problem-solving strategies. In other words, we "teach you how to fish," rather than simply "give you fish."

Although one of the main goals of this book is to help you develop knowledge in the area of technology integration, perhaps more importantly, our goal is to provide you with a number of learning strategies you can use to solve unexpected problems and to build your own understanding of what it means to be an exemplary technology-using teacher. We have included a number of organizational and pedagogical features, some briefly described next, to help you develop these additional forms of knowledge and to build and hone your SDL skills.

New to This Edition

You'll find that this new edition maintains the foundation we established in the first two editions, however, we also recognize that as technology and our goals for how to use it change, this book must change and improve as well. As a result, in the third edition you'll see *new content* related to:

- personalized learning;
- blended and online learning;
- design thinking;
- computational thinking (including using coding activities in your classroom);
- makerspaces;
- instructional design as both process and product;
- the responsible use of technologies;
- digital literacy, media fluency, and information literacy; and
- student data privacy.

In addition, content from the second edition has been expanded to include a *greater focus* on:

- developing a problem-solving culture to engage students in complex problem solving;

- authentic learning in support of deeper learning;
- student-directed learning strategies and approaches;
- innovative digital learning environments including virtual, online, and blended learning contexts; and
- facilitating online and face-to-face discussions.

All key features from the second edition have been added to and/or updated for the third edition. The text now includes more than 30 *Stories from Practice* (approximately two to three per chapter) from practicing teachers. The following list includes descriptions and examples of some of the updated key features. As was true for our previous two editions, each chapter includes:

- *ISTE Standards*. Each chapter begins with a list of the 2017 ISTE Standards for Educators that are addressed in that chapter.
- *Learning Objectives*. Also at the beginning of each chapter is a list of learning objectives to guide you in your reading.
- *Stories from Practice*. Case studies, anecdotes, and interviews with practicing teachers are used to place the content within the context of real classrooms. There are even more stories in this edition than the last two, so you'll have the opportunity to hear how teachers are using new technologies and new pedagogies to transform their students' learning experiences. You'll find a guide to all of the *Stories from Practice* in Appendix A.
- *Tech Tools & Tips*. New *Tech Tools & Tips* boxes provide brief descriptions or examples of the latest technology tools (e.g., mobile apps; shared productivity tools), trends (e.g., blended and online learning; collaborative creation), and strategies (e.g., supporting students' efforts to be self-directed; facilitating discussions) that are important to consider when planning for technology integration.
- *GAME Plan*. Through the use of self-directed learning activities, we model metacognitive strategies that guide the development of problem-solving skills. This feature incorporates an easy-to-remember acronym called the GAME plan.
- *Apply to Practice*. Throughout the chapters, activities are embedded that ask you to apply your knowledge to practical problems, investigate the topics in more depth, reflect on your practice, or share your developing knowledge with other members of your learning community.
- *Your Portfolio*. At the end of each chapter, suggestions for portfolio-based artifacts are provided to help you demonstrate and document your progress toward attaining the ISTE standards addressed in the chapter.

In addition to these standard chapter features, several other helpful items are provided to enhance your learning:

- Updated *end-of-book appendices* provide a matrix that highlights which *Stories from Practice* apply to the different content areas and grade levels and a guide to their use; detailed guidance for those required to or just interested in creating a professional portfolio based on their use of this book; and examples of technology integration in practice, including the use of assistive technologies to benefit students with special needs and tips for safe and healthy use of technology with all students.
- Each chapter concludes with a *summary of the chapter content,* a list of key terms, and a list of references.
- In addition, *bold-faced key terms* within each chapter indicate important words that are defined in the glossary.
- The back matter includes a *glossary of key terms and an index*.
- The *Standards Correlation Chart* on the inside front and back covers provides an easily accessible listing of the chapters that address specific ISTE standards.

Accompanying Teaching and Learning Resources

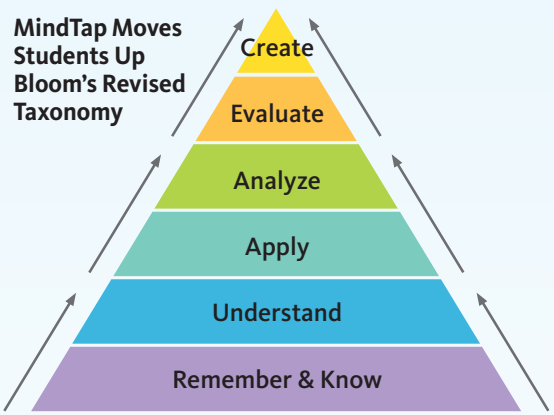
MindTap™: The Personal Learning Experience

MindTap Education for *Technology Integration for Meaningful Classroom Use,* Third Edition, represents a new approach to teaching and learning. A highly personalized, fully customizable learning platform with an integrated ePortfolio, MindTap helps students elevate their thinking by guiding them to:

- know, remember, and understand concepts critical to becoming a great practitioner;
- apply concepts, create curriculum and tools, and demonstrate performance and competency in key areas in the course, including national and state education standards;
- prepare artifacts for the portfolio and eventual state licensure, to launch a successful professional career; and
- develop the habits to become a reflective practitioner.

As you move through each chapter's learning path, you will engage in a scaffolded learning experience, designed to move you up Bloom's taxonomy, from lower- to higher-order thinking skills. The learning path enables you to develop these skills and gain confidence by:

- engaging with chapter topics and activating your prior knowledge by watching and answering questions about authentic videos of teachers teaching and children learning in real classrooms;
- checking your comprehension and understanding through *Did You Get It?* assessments, with varied question types that are autograded for instant feedback;
- applying concepts through scenarios—you'll analyze typical teaching and learning situations, and then create a reasoned response to the issue(s) presented in the scenario; and
- reflecting about and justifying the choices you made within the teaching scenario problem.



Anderson, L. W., & Krathwohl, D. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

MindTap helps instructors facilitate better outcomes by evaluating how future teachers plan and teach lessons in ways that make content clear and help diverse students learn, assessing the effectiveness of their teaching practices, and adjusting teaching as needed. MindTap enables instructors to facilitate better outcomes by:

- making grades visible in real time through the Student Progress App so students and instructors always have access to current standings in the class;

- using the Outcome Library to embed national education standards and align them to student learning activities, and also allowing instructors to add their state's standards or any other desired outcome;
- allowing instructors to generate reports on students' performance with the click of a mouse against any standards or outcomes that are in their MindTap course; and
- giving instructors the ability to assess students on state standards or other local outcomes by editing existing or creating their own MindTap activities, and then by aligning those activities to any state or other outcomes that the instructor has added to the MindTap Outcome Library.

MindTap Education for *Technology Integration for Meaningful Classroom Use*, Third Edition, helps instructors easily set up their courses because it integrates into existing learning management systems and saves instructors time by allowing them to fully customize any aspect of the learning path. Instructors can change the order of the student learning activities, hide activities they don't want to use in the course, and—most importantly—create custom assessments and add any standards, outcomes, or content they want (e.g., YouTube videos, Google docs). Learn more at www.cengage.com/mindtap.

Online Instructor's Manual

The instructor's manual contains a variety of resources to aid instructors in preparing and presenting text material in a manner that meets their personal preferences and course needs. It presents chapter-by-chapter suggestions and resources to enhance and facilitate learning.

Online Test Bank

The Test Bank contains multiple-choice and essay questions to challenge your students and assess their learning.

Cengage Learning Testing Powered by Cognero

The Test Bank is also available through Cognero, a flexible, online system that allows you to author, edit, and manage test bank content as well as create multiple test versions in an instant. You can deliver tests from your school's learning management system, your classroom, or wherever you want.

Online PowerPoint Lecture Slides

These vibrant, Microsoft PowerPoint lecture slides for each chapter assist you with your lecture, by providing concept coverage using images, figures, and tables directly from the textbook.

Acknowledgments

Throughout this journey we have benefited from the support, advice, and encouragement from a number of individuals, including Phyllis Newbill and Elza Cruz who provided invaluable assistance in tracking down images, securing permissions, and organizing information for the first edition; and Marina Sotelo who conducted research for this third edition. We owe a debt of gratitude to the many teachers, coaches, and other educators from across the country who have contributed stories from their own

practice to help bring the concepts in this book to life. And for tolerating our absences throughout the many evenings, weekends, and holidays that we spent working on this book, we offer a heartfelt thanks to Arthur, Elliott, and Alice Cennamo; Jeff Mann; and Dave Ertmer.

We would also like to extend a special thanks to Jessica Alderman, our content developer, who was always on our team, sharing our work ethic, responding to many emails, and generally supporting us throughout this endeavor.

And finally, we would like to express our appreciation to numerous reviewers who provided us with insights and suggestions throughout the development of this edition, including:

Katherine Brandon, EdD, Concordia University Chicago
Bradley J. Burenheide, Kansas State University
Kristen Carlson, St. Cloud State University
Dr. Kisha R. Cunningham, Savannah State University
Amanda L. Eller, PhD, Idaho State University
Dr. Cindi H. Fries, Northeastern State University, College of Education
Dr. Aliya Holmes, St. John's University
Ellen Maddin, EdD, Northern Kentucky University
Vanessa Niedzwiecki, University of North Florida
Travis S. Plowman, The College of Saint Rose
Jacqueline Rippy, MS, ABD, Florida State College at Jacksonville
Ludovic A. Sourdot, PhD, Texas Woman's University
Sarah Vogt, Central New Mexico Community College

Reference

International Society for Technology in Education. (2017). *ISTE standards for educators: A guide for teachers and other professionals*. Arlington, VA: Author.

About the Authors

Courtesy Katherine Cennamo

Courtesy John Ross

Courtesy Peggy Ertmer

Katherine S. Cennamo is a former elementary teacher and is currently professor of Instructional Design and Technology at Virginia Tech. She earned a bachelor's degree in elementary education from Virginia Tech, a master's degree in educational media from the University of Arizona, and a PhD in instruction technology from the University of Texas at Austin. Throughout her career, Dr. Cennamo's work has focused on the application of learning theories to the design of technology-based instructional materials. Through numerous funded projects, publications, presentations, instructional materials, and teaching activities, she has disseminated knowledge of instructional strategies based on established theories of learning. She has applied this knowledge to prepare future instructional design professionals in the textbook *Real World Instructional Design,* co-authored with Debby Kalk. Her current research activities focus on developing and sustaining a classroom culture that fosters critical and creative thinking skills in K–12 and higher-education environments.

John D. Ross is an educational technology consultant who works with national and state leaders as well as actively helping districts and schools across the country plan for, implement, and evaluate technology initiatives that support teaching and learning. Dr. Ross was a classroom teacher for 10 years prior to serving as a senior R&D specialist for a nonprofit educational laboratory working on a range of technology-related projects funded primarily by the U.S. Department of Education. He is the author of the best-selling book *Online Professional Development: Design, Deliver, Succeed!* (Corwin). He has served as a guest lecturer and adjunct faculty member, a technical assistance specialist for the Appalachia Regional Comprehensive Center, and a mentor for coaches and teachers implementing online and blended learning, performance-based tasks, and problem-based learning. He holds a PhD in curriculum and instruction and instructional technology from Virginia Tech.

Peggy A. Ertmer is Professor Emerita in Learning Design and Technology in the Department of Curriculum and Instruction at Purdue University. Prior to earning her PhD at Purdue, Dr. Ertmer was an elementary and special education teacher in the K–12 schools. Dr. Ertmer's research examines the impact that student-centered instructional approaches and technology-enabled strategies have on learning. She actively mentors educators in the use of case-based and problem-based learning pedagogy, technology tools, and self-regulated learning skills. Dr. Ertmer served as a content expert for a series of videos (www.edutopia.org/video/five-keys-rigorous-project-based-learning) about project-based learning for Edutopia, a George Lucas Educational Foundation. She has published over 75 peer-reviewed articles, has co-edited four editions of the *ID CaseBook: Case Studies in Instructional Design,* and is the founding editor of an open-access, online journal, the *Interdisciplinary Journal of Problem-based Learning,* published by Purdue University Press. In 2014, Dr. Ertmer received the David H. Jonassen Excellence in Research Award from the Association for Educational Communications and Technology, and was selected to join the 2015 Class of AERA Fellows.

Technology Integration: A Standards-Based Approach

1

Rawpixel.com/Shutterstock.com

LEARNING OBJECTIVES

After reading this chapter, you will be able to:

1-1 Describe the history of technology integration in relation to your teaching practice.

1-2 Identify the technology standards that will guide your professional development.

1-3 Locate your current placement on the technology integration continuum.

ISTE Standards for Educators Addressed in Chapter 1

This chapter introduces the technology standards of the International Society for Technology in Education (ISTE), on which this book is based. ISTE is an organization whose mission is to provide "leadership and service to improve teaching, learning, and school leadership by advancing the effective use of technology in PK-12 and teacher education" (ISTE, 2008). We introduce both the 2017 ISTE Standards for Educators and the 2016 ISTE Standards for Students. These standards are placed in the context of the historical uses of technology in education. We address the value of standards for ensuring consistency in the quality of instructional experiences for all students. The chapter concludes with scenarios that illustrate how the application of ISTE standards affects the role of teachers, the role of students, the resources used, and the instructional activities that occur within the classroom.

Imagine yourself teaching a lesson to a classroom of students. Exactly what would you do to engage your students in the relevant content? Would you use technology? If so, what technologies, and why? If not, why not? Now consider the technologies you use every day. If you are like many college students, computers, cell phones, tablets, and other digital tools are interfaces to your life. You communicate there. You think there. You create there. You take care of the day-to-day events of your life there. You are entertained, informed, stimulated, and soothed. Technology provides a window into your world. But have you thought about how you will integrate technology into your teaching practice?

Our goal in writing this book is to help you build on these familiar technology experiences to learn the skills you need to

successfully leverage technology to redefine teaching and learning for the digital age. In December 2016, the United States Department of Education issued a policy brief that stated, "Our students deserve to have teachers, including novice teachers, who are fully prepared to meet their needs. In today's technology-rich world, that means educators need to be prepared to meaningfully incorporate technology into their practice immediately upon entering the classroom" (2016a, p. 4). This is, quite simply, the goal of this textbook.

Specifically, this book was written to help you meet the 2017 ISTE Standards for Educators. Four premises provide the foundation for our approach:

1. You are a lifelong learner. This is best summed up by the proverb, "Give a man a fish and you feed him for one day. Teach a man to fish and you feed him for a lifetime." Based on this premise, we have included strategies to support your continued learning, even after this text is completed.
2. Technology provides a *tool* for solving problems—in your case, instructional problems—as opposed to *being* a problem as in, "How can I use technology in my class?"
3. It's more important *how* you use technology than *if* you use it. This might sound strange, especially in a technology textbook, but we believe that the decisions you make about integrating technology are based on what you know and believe about good teaching. Although we describe many different uses of technology in this text, we believe that "best practice" is achieved more readily when technology is used to support an authentic learner-driven curriculum.
4. Multiple technologies, including computers, cell phones, tablets, and other mobile devices are a natural part of our lives. Most new teachers today have grown up with digital technologies. Some of you have encountered more technologies and some less, but all of you have had access to numerous, and often very powerful, technologies for much of your lives, whether in your schools, homes, jobs, colleges, or other locations. You will be the first generation to naturally use such powerful technologies for teaching and learning, and you are poised to use them in ways we have yet to imagine.

Educators have long recognized that effective teaching requires that you possess more than content knowledge of math, social studies, Spanish, or whatever your discipline may be; it also requires pedagogical knowledge (i.e., knowledge of how to teach) and pedagogical content knowledge (i.e., knowledge of how to teach specific content) (Shulman, 1986). More recently this framework has been expanded to recognize the essential role of technological knowledge (Mishra & Koehler, 2006), and its intersection with both content and pedagogical knowledge. You will learn specific content and pedagogical knowledge related to your discipline in other courses throughout your college career. In this book, we focus on the intersection of pedagogical knowledge and technological knowledge—in other words, how to teach specific content using appropriate technology tools. As we address this intersection, we'll introduce you to ways to use technology to provide your students with meaningful learning experiences as well as ways in which technology can support you in this process.

1-1 Technologies in Teaching and Learning: A Historical Perspective

Technologies have been part of teaching and learning for centuries. As the types of technologies have changed over the years, so, too, has their importance to the teaching and learning process. For example, consider two functions of technology—communication and information storage—and how they have evolved from

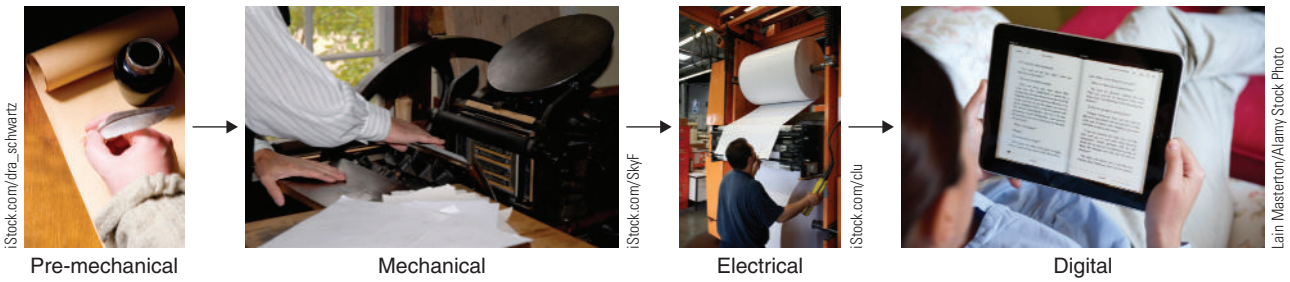


Figure 1-1
Information and communications technologies throughout history.

pre-mechanical forms to mechanical to electronic and then to digital forms (see Figure 1-1). By improving existing technologies and developing new technologies, information and communication technologies have become more accessible to the general public while simultaneously offering increased speed and greater quality. Can you imagine your life without cell phones, the Internet, and other digital tools that help you communicate with your friends and family?

If you were a teacher when very simple communication and information storage tools were available—in a time referred to as the pre-mechanical era—you would have had to depend on real objects and face-to-face communication with your students to describe the past, explain the present, and encourage thinking about the future. The accessibility of pre-mechanical forms of information and communications technologies (such as quill, ink, and paper) and their products (such as legal proclamations and religious documents) was quite limited—often reserved for wealthy members of society. Neither the technologies nor their products were used extensively in educational settings.

As technologies moved into the mechanical phase through the creation and use of the printing press, it became possible to produce greater quantities of the products in a form that allowed teachers to retrieve and use information over an extended period of time. Storing and communicating information became much easier—for teachers, students, and the general public. Reliance on face-to-face communication lessened as books were printed and became more plentiful and accessible to wider audiences. Books were the new information technologies!

As information technologies entered the electronic age, accessibility increased even further. The widespread use of the phonograph, radio, and television increased opportunities for communication. You may not believe it, but when these technologies were first introduced, all of them were predicted to be valuable teaching tools. The development of audio and video recorders meant that information captured by these tools could be preserved on tape and then made available to the public and, of course, to educators.

As technologies entered the digital phase, additional communication tools were developed. Word processors, digital cameras, email, cellular phones, and a continuing array of information and communication tools have been, and will continue to be, developed. Also, because of the ease with which digital information can be duplicated and transferred to other locations, high-powered storage and retrieval systems and software have become common in places you might not consider—such as your car, television, and refrigerator. In fact, you might already access your textbooks through online databases or websites, or use devices such as your smartphone or tablet to view or listen to your text and associated media files. Furthermore, these devices can also be controlled remotely, often using your smartphone—a phenomenon we now call the Internet of Things (IoT). You may, for instance, be familiar with systems to remotely control your home temperature or lights from a distance; a watch or fitness band that tracks your physical activity; or a device you can speak to in natural language to find information,

shop, and control other devices in your home. These connected technologies also have powerful implications for education. School systems can use IoT technology to track school buses, student attendance, and a multitude of other things (Brown, 2017).

The impact of technological improvements and innovations on education obviously goes well beyond the areas of **information and communications technology**, now commonly referred to as **ICT**. For example, the sheer abundance of information available, and the ease with which it can be freely disseminated, have created the need to carefully evaluate the accuracy and credibility of information and to curate information from a variety of sources to create meaningful collections. The sheer abundance of data collected as we go about our day-to-day lives has created concerns about data security and personal privacy. Networked technologies offer individuals from across the globe opportunities to freely communicate with each other, but have also created a need for increased cultural awareness and responsible digital citizenship. Technologies provide opportunities for people to be creators as well as consumers of information and have created the need to practice perseverance in developing potential solutions to complex problems and seeking and incorporating feedback.

Later chapters in this text will present numerous ways in which modern technologies can enhance your teaching and your students' learning. We will discuss the many results you may expect through the effective use of digital tools and resources in your classroom, and increase your awareness of the knowledge, abilities, skills, resources, and environments required for you to use them successfully. Specifically, we'll focus on computer use and related digital technologies in support of teaching and learning in educational environments.

1-1a Computer Technology in Education

It is customary when discussing computers in education to begin with a history of computers and to break this history into a relatively small number of meaningful phases. This history typically goes back to well-known predecessors of modern computers such as the automated loom, Babbage's difference engine, or the abacus. Although accounts of these early predecessors are often quite engaging, they may not seem very relevant to current computer users.

Photo 1-1
Introduced in 1977, the Apple II was the first commercially successful microcomputer.

For most of you reading this text, the practical history that matters is largely within your own lifetime. It begins—perhaps a bit before your lifetime—with the first commercially successful "microcomputer," the Apple II introduced in 1977, and gains momentum with the first IBM PC in 1981, followed by the first Macintosh in 1984 (see Photo 1-1). In its relatively short history, the computer has become more powerful, flexible, and easier to use. And yet, educators continue to struggle to understand and embrace the role of computers and other digital technologies in the classroom (see Table 1-1).

Phase One: Computer as Object of Study (1977–1982)

At first, the computer itself was an object of study because computers were supposed to be the wave of the future—everyone

Table 1-1 Computers in Education Timeline

First Phase: The computer as an object of study (1977–1982)	
1977 Apple II is introduced	First microcomputer brings computing from the scientific, mathematical domain to home, school, and work settings.
1981 IBM releases the first PC	IBM releases DOS-based computers and coins the term *PC,* or *personal computer,* the new concept in computer technology.
1982 Increased attention	The computer is named *Time* magazine's "Person of the Year," the individual who has had the greatest impact on world events during the year.
Educational software introduced	Drill-and-practice educational software programs predominate.
Educational emphasis	Emphasis is placed on computer literacy: learning *about* technology.
Second Phase: The computer as programming tool (1983–1990)	
1983 Logo programming language	Logo programming gains acceptance in education as a means to address students' higher-order thinking and problem-solving skills.
TCP/IP, SMTP, FTP, HTTP	Standardized communications language, TCP/IP, enables communication between computers via network—the Internet for the "common man" is born.
1984 Macintosh	Apple's Macintosh introduces the terms *desktop* and *icon* into everyday language and ushers in more variety in educational software.
1987 Hypertext	Hypermedia becomes readily accessible with the distribution of HyperCard software on Macintosh computers.
1990 Multimedia boom	Multimedia PCs are developed; simulation software and gaming grow in popularity and complexity; educational databases and other types of digital media are available on CD-ROMs.
Educational emphasis	Emphasis is placed on learning programming languages and using "programmed instruction" such as drill-and-practice software.
Third Phase: The computer as a communication device and resource tool (1991–1996)	
1991 WWW is born	Tim Berners-Lee and Robert Cailliau began using hypertext to link different kinds of information as a web of nodes, which learners could access at will.
1993 Mosaic released	The release of Mosaic, a browser with a graphical user interface (GUI), changes the look of Internet communications. "Surfing the web" becomes commonplace.
1993 White House goes online	President Clinton's administration develops www.whitehouse.gov. This heralds a new frontier in website development, with an abundance of educational sites for children.
1995 Windows OS released	Microsoft releases the Windows 95 operating system. *Toy Story* is released, the first feature-length movie that is entirely computer generated.
1996 First Ed Tech plan, First national "Net Day"	The first U.S. National Education Technology Plan is developed. Volunteers help wire local schools for Internet access and local area network (LAN) infrastructure.
Digital explosion	Technology tools grow at an exponential rate and become faster, smaller, and more powerful. Digital music, pictures, audio, video—the applications of this new wave of technology—are virtually limitless.
Educational emphasis	Emphasis is placed on information literacy: learning *with* computers. National education goals emphasize the acquisition of computer hardware and the development of network infrastructure.
Fourth Phase: The computer as learning and social tool (1997–2009)	
Web 2.0	Teachers and students move from being consumers to becoming creators of online content using wikis, blogs, and other social networking tools.
Anywhere/anytime learning	Teaching and learning move outside the classroom to include online and hybrid courses, delivered via learning management systems, as well as mobile learning opportunities using smartphones, netbooks, and tablet computers.

(*continued*)

Table 1-1 Computers in Education Timeline (*continued*)

Educational emphasis	Emphasis is placed on ICT literacy: Foundational information, communication, and productivity skills remain consistent while tools continue to change. Technology becomes a tool for solving educational problems. Emphasis is also placed on *literacy with and through technology,* using technology as a learning tool to enable students to master 21st-century skills such as critical thinking, complex problem solving, collaboration, and multimedia communication.
Fifth Phase: Technology-enabled learning (2010–present)	
Increased emphasis on design and associated thinking skills	STEM (science, technology, engineering, and math) labs in schools begin to be used in support of the maker movement. U.S. President Barack Obama hosted a maker faire at the White House in 2014. Inexpensive digital tools for "tinkering" and programming, including microcontroller platforms, programmable robots, gaming platforms for kids, as well as rapid-prototyping tools such as 3-D printers, become prevalent. Increased emphasis on "design thinking" leads to the establishment of design labs in schools.
Renewed interest in programming skills	In 2013, the Hour of Code organization (code.org) was established and dedicated to making computer programming accessible to all.
Ubiquitous, mobile computing	A continued shift to accessing content on mobile devices such as smartphones and tablets was fueled in part by the release of the popular iPad tablet in 2010, with an increased interest in harnessing the power of devices connected through the Internet of Things (IoT) for educational purposes.
Emphasis on harnessing the power of technology to enhance pedagogy	Anytime, anywhere access to learning materials increases potential for schools to o□er blended learning, flipped classrooms, and other similar models that combine online and face-to-face learning experiences. Competency-based models begin to replace the concept of "seat time," leveraging flexible access to personalized learning opportunities for students, leading to more student-driven curricula.

would need to know how to use them. The computer's entry into the mainstream classroom in the 1980s prompted the creation of new curricula and standards in an effort to help students become **computer literate.** If you had been in school in the 1980s, you might have taken a computer class in which you learned about the history of computers, including the fact that they used to be so big they filled an entire room or series of rooms. You would have learned about now antiquated punch cards and tape drives. Your studies also may have focused on learning the parts and functions of a computer, rather than how to use it as a tool for learning. The yet-to-be-developed World Wide Web would not have been mentioned as you worked on stand-alone machines, and you probably would have created rudimentary programs using computer languages such as BASIC (see Figure 1-2). Being computer literate meant that you understood computer history, computer architecture and terminology, basic software applications, and programming. Being **technologically literate** is still important today, but the exact meaning of this term (as well as others such as *technology proficiency* and *information literacy*) continues to evolve, primarily because technology itself evolves.

Drawing on the earlier lessons of large-scale, mainframe computers, early instructional software was often created by computer scientists, engineers, and mathematicians. Educators or instructional designers were seldom, if ever, involved even though the goal was to design software that could teach. As you might expect, given that the early machines were not very powerful and the software creators were seldom educators, much of the software from this era was not especially memorable. The idea of designing programs to teach, of course, has survived and matured. Now such programs are usually developed by teams of educators, instructional designers, graphic designers, and programmers, and then are tested with real students.

Phase Two: Computer as Programming Tool (1983–1990)

The second phase of computers in education was initiated largely in response to the development of the computer language Logo, which was based on an earlier computer programming language called Lisp (see Figure 1-3). Lisp was a complex programming language originally designed to handle mathematical notation and was used in early artificial intelligence programming. In an attempt to make aspects of Lisp more applicable to education, Wally Feurzeig and Seymour Papert developed Logo (Papert, 1980). Using the Logo programming language, users solved geometric problems by moving a robot-like "turtle" around the floor, and later, by moving a computer-generated "turtle" icon across the computer screen. Also during this period, Ted Nelson advanced the notion of "hypertext." Hypertext allowed users to follow links to related information just like you follow hyperlinks on the web. Hypertext quickly blossomed into "hypermedia," in which buttons, images, and other objects could contain hyperlinks. One of the early multimedia development programs, HyperCard, came bundled with the software that was included on Macintosh computers. With the subsequent release of other multimedia development tools such as SuperCard, also on the Mac, and ToolBook on the PC, hypermedia flourished. Hypermedia, of course, is still used today, and is most often encountered on websites that contain multiple media and hyperlinks to remote resources.

```
10 INPUT "What is your name?"; N$
20 PRINT "Hello "; N$
30 REM
40 INPUT "Do you use technology? Y/N"; A$
50 IF (A$ = "Y") THEN GOTO 70
60 IF (A$ = "N") THEN GOTO 80
70 PRINT "Good for you!";
80 PRINT "You should!";
90 PRINT "Goodbye";
100 END
```

Figure 1-2
In the 1980s, being technologically literate meant learning to program in computer languages like BASIC.

These two advancements—(1) the potential of using programming to teach general problem-solving skills, and (2) hypermedia's potential to "open up" learning software by providing learners with control of their unique paths through the content—heralded

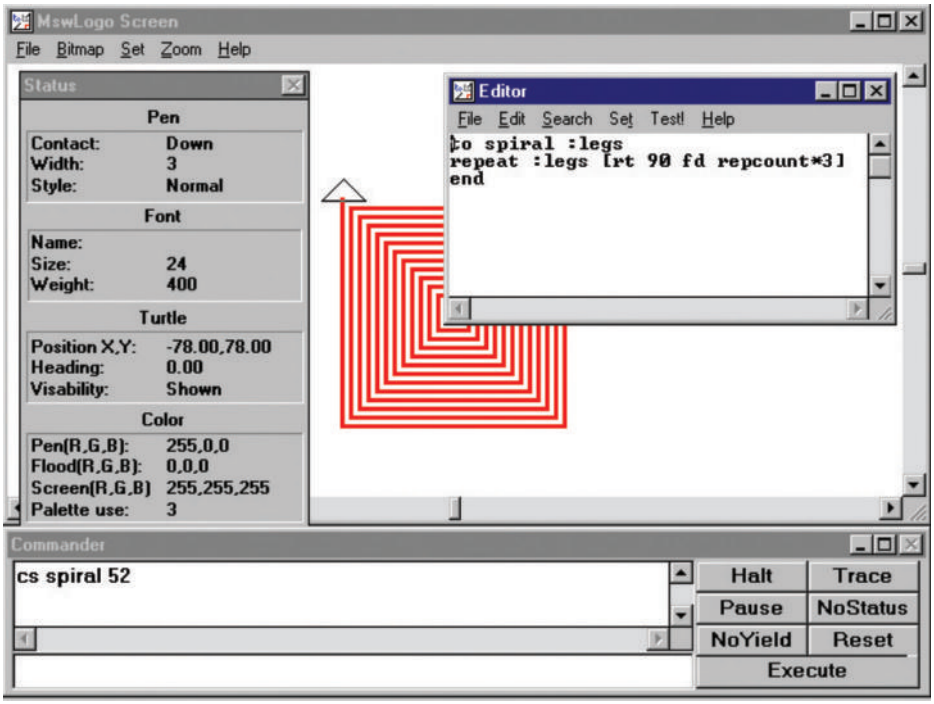


Figure 1-3
The early programming language Logo helped make programming applicable to education.

the use of the computer as a device for developing higher-level thinking skills. We now know that teaching programming languages to increase general problem-solving skills isn't any more effective than the notion, prevalent at the end of the 19th century, that teaching Greek would "discipline the mind." We also know that open-ended hyperspace that allows students to "find their own paths" through content often leads to no cohesive path at all. Just think about how often you have followed interesting links while using the Internet, only to realize that you had (unfortunately) spent way too much time, lost track of what you were doing, and not completed what you really needed to accomplish—it *is* called "surfing" after all.

As computers moved from cumbersome DOS-based systems to easier graphics-based interfaces with the introduction of the Macintosh and then Windows operating systems in the mid-1980s, the emphasis gradually shifted from learning programming languages to learning how to use new **productivity applications**, such as word processors, spreadsheets, and databases, that were becoming commonplace in the world of work. As interest in teaching programming languages faded, we entered the third phase of computer use in education.

Phase Three: Computer as Communication Device and Resource Tool (1991–1996)

The third phase of computer use in education focused on using computers as classroom communication devices and as tools to access resources. With the development of easy-to-use desktop publishing and presentation software, teachers and students began to use these to organize instruction or demonstrate learning in colorful displays. However, materials created with productivity tools, especially presentation software, were also sometimes confusing, especially when they incorporated features such as audio, graphics, and animations at the expense of sound teaching strategies.

This movement toward the use of computers as communication devices and resource tools was further grounded in projects funded by the Advanced Research Projects Agency Network (ARPANET). The ARPANET was an early computer network that initially linked scientists and engineers, permitting communication and providing a shared space for collaboration. The size of this early network grew from six connected nodes in the early 1970s to a hodgepodge of several hundred connections by 1983, when a single standard for transmitting digital information across the network, TCP/IP (which stands for transmission control protocol/Internet protocol), was adopted. TCP/IP (and subsequent standards such as Simple Mail Transfer Protocol, or SMTP) opened up this early "hodgepodge" to almost anyone with a computer. This early network was a critical step toward creating the Internet that has become part of all of our lives. The subsequent explosion of networked resources made information *and* misinformation widely available; anyone with a computer could "publish" research, opinion, news, or a wide range of questionable material. The potential for connecting students to each other and to the global community was unleashed.

Initially, there was a widespread belief that placing technology in the schools would make a difference in the way teachers taught and students learned in this new, networked society. Thus, "one computer for every five students" became a U.S. national goal (e.g., President's Committee of Advisors on Science and Technology, 1997); cash-strapped school systems rushed to get computers and networking infrastructure in place (see Photo 1-2). This ultimately led to the question of how to integrate these technologies effectively into the classroom.

Phase Four: Computer as Learning and Social Tool (1997–2009)

Despite encouragement from policy and education leaders, it took practicing educators a while to shift their emphasis from learning *about* technology to learning *with* technology (Jonassen, 1996), while simultaneously trying to keep up with the many

Photo 1-2
As a result of the first National Educational Technology Plan, schools sought to put computers in every classroom.

changes in the technology itself. Widespread access to the Internet and the growth of web-based information forced a paradigm shift in terms of what technology proficiency looked like and might become. Although the term **information literacy** became popular during the third phase and was a focus of the second U.S. National Education Technology Plan (U.S. Department of Education, 2000), the meaning of the term shifted toward developing new literacies made possible by technology. This shift toward finding, analyzing, creating, and sharing information encouraged educators to consider how technology tools could be used to support learning rather than requiring students to learn basic skills for tools that would soon be outdated.

Given this change in emphasis, it wasn't long before colleges and universities, and even private and commercial organizations, began offering online and blended, or hybrid, courses to enable students from across the country and even around the world to enroll in degree programs. Online learning quickly became one of the fastest growing trends in the educational uses of technology, both at the K–12 and the college levels. In 2007, Picciano and Seaman estimated that nearly one million K–12 students had taken an online course in the previous school year. Allen and Seaman (2010) reported that over 5.6 million students at the college level had taken at least one online course during the fall 2010 semester! It is highly likely that you, too, have experienced this increasingly common type of course delivery.

Web-based applications evolved to the point where it was very easy for web users, including teachers and students, to move from being passive consumers of information to creators of information, in a range of media formats. We're sure you are familiar with social networking tools, once referred to as Web 2.0 tools, that allow you and your students to quickly post text, images, videos, and other media, which other users can then comment on or add content to. You can bookmark information on the web and share those sites with friends and colleagues, a process sometimes called social bookmarking. Examples of this form of socially generated content include the popular

TECH TOOLS &TIPS

Teaching Online

Numerous school districts offer some form of distributed learning classes where one teacher provides instruction for students at a variety of locations. Specialized courses that may not attract enough students at one school to justify hiring a teacher can be offered through distributed learning that combines students across sites. And, of course, virtual schools offer coursework to students who are homeschooled or otherwise unable or unwilling to attend traditional schools. In fact, several states have added online teaching requirements to their teacher certification systems.

The National Education Association (n.d.) recommends that, at a minimum, training for online teaching for preservice teachers include:

- evaluating Internet resources for validity of content;
- respecting and enforcing copyright concerns, including Technology, Education, and Copyright Harmonization (TEACH) Act provisions;
- identifying outstanding educational websites for both teacher and student reference;
- addressing issues of accessibility and Section 508 compliance, including adaptive software for the physically, visually, and hearing impaired;
- employing appropriate "etiquette" and observing acceptable use policies; and
- learning to develop lesson plans that foster Internet research skills in students. (pp. 12–13)

Each of these topics is addressed in this book!

Source: National Education Association, *Guide to Teaching Online Courses,* pp. 12–13 (www.nea.org/assets/docs/onlineteachguide.pdf).

networking sites like Facebook and Google+; Wikipedia, the online, user-created encyclopedia; YouTube and education-specific video repositories like TeacherTube; Flickr, an online photo sharing site; and any number of weblogs—or blogs—created by education journalists, teachers, and even students. You no longer need to know how to program for the web to post a daily journal or create your own online reference with text, graphics, video, and other media. But as was true for most innovative technologies, teachers struggled to integrate these new tools into their classrooms.

In the first decade of the new millennium, all of this content—whether education-related or not—became increasingly accessible through mobile devices, such as iPods, smartphones, and after 2010, the iPad and other tablet computers. Mobile learning became the latest frontier in terms of leveraging information to support teaching and learning. Students were able to access and create information, whether in or out of class, with these small, portable devices that utilized web browsers or education-specific applications ("apps" for short). This next generation of tools made its way into the hands—and classrooms—of many students and will undoubtedly continue to grow in popularity as the devices become less expensive and more powerful.

On a national level, several organizations in the United States attempted to create definitions of technology literacy or technology proficiency. These definitions reflected the view that many information, communication, and productivity skills will remain constant while the tools we use to demonstrate them will change. In their description of ICT literacy, the Partnership for 21st Century Skills (2004, 2007) promoted the notion that to be competitive in this new millennium, K–12 students must develop a core of foundational skills—skills many now associate with "deeper learning." However, in the 21st century, these skills are often learned with, and facilitated by, the use of ICT tools such as email, the Internet, and productivity software.

Phase Five: Technology-Enabled Learning (2010–current)

Although the focus of the fourth phase was on using digital technologies as social and learning tools, in the last decade, the emphasis has shifted from *digital tools* to *digital*

APPLY to Practice

Defining Technology Literacy

Over time, many organizations have attempted to define computer literacy, information literacy, and technology literacy.

1. Find definitions for any of these terms from public and private national organizations, your college or university websites, or other sources. Capture a few of the definitions you find and determine whether you agree with them, and if so, to what degree.
2. Log on to a site that covers computer history, proficiency, or literacy. How do these different sources define computer, information, and technology literacy?
3. Discuss your findings with a group of peers. Would you consider yourself to be technologically literate? Based on which definition? What consensus can you reach in your group?

learning. The 2010 version of the National Education Technology Plan (NETP; U.S. DOE, 2010) emphasized technology for learning, rather than technology for teaching, and challenged educators to leverage technology to create "engaging and empowering learning experiences for all learners" (p. 4). The 2016 and 2017 updates continued the theme of using technology to transform learning, while reinforcing the need for equitable access both at home and at school (NETP; U.S. DOE, 2016b; 2017). No longer is the goal simply to place technology in the classroom. Rather, the goal is for these tools to become as important to the "work" of teaching and learning as power tools are to the work of building a house.

As ISTE members looked back across the last 20 years of technology use in education, they described a shift in focus from learning to use technology (in the 1998 standards) to using technology to learn (in the 2007 standards) to the current emphasis on using technology to transform how we teach and learn (ISTE, 2017b). Think about how you may grab your phone to find information at the point of need, download podcasts to inspire or inform you, follow the blog or Twitter feeds of someone you admire, or curate your own preferences on Pinterest or Instagram. Now think about the differences between a classroom in which all these things happen as naturally as they do in the rest of your life, and a classroom in which they don't. As such, the conversation on transforming learning with technology focuses on the opportunities for learning that technology *enables*. The speed, processing capabilities, and storage capacities of computers provide opportunities for learning in ways that have only been imagined previously.

There is no doubt that digital technologies enable pedagogical practices that would be challenging, if not impossible, without them. For example, the ability to target instruction to the needs of each and every learner has been a dream of educators for decades. Early computer-assisted instruction held the promise of personalized learning for each and every student but only recently have developments in computing power and storage made that possible, enabling teachers to enact not just student-centered instruction, but student-driven learning. Today, adaptive learning systems offer students the opportunity to complete a pre-assessment, then based on the students' needs and learning preferences, they draw from an extensive database to provide each student with the appropriate instructional materials. For skills that are not readily assessed via computer, the storage capacity of modern digital tools makes it possible to create, store, and access comprehensive portfolios of products to document students'

growth and progress. Students can create their own individual learning plans and link to evidence of their progress and learning. Materials, both those created by students and those curated by others, are most typically stored on remote servers. Teachers can access these materials and provide feedback to their students anywhere and at any time that they have access to Internet service. This access is, more and more often, provided through smartphones or other mobile devices.

The ability to store and access learning materials and student performance data in remote locations that can be accessed anytime, anywhere opens up the classroom and enables pedagogies such as blended learning, flipped classrooms, and other learning models that combine face-to-face and digital learning. In a flipped classroom approach, students come together to do the things that are best done together. In talking about the transformative power of technology, Lehman and Chase (2015) noted: "Whereas previously, we came to school because the teacher was there, now we come to school because we are all there together" (p. 58). The authors challenge us to "find ways to make learning more communal so that there is a reason to be in the room together. And then leverage tools such as Google's G Suite for Education and learning management systems like Canvas to enable the idea of 'coming together' to encompass more than just physical space" (p. 47).

The current emphasis on technology-enabled learning can be seen in the popularity of the maker movement in which students are encouraged to use digital tools in the service of problem solving, tinkering, and creating. The development of low-cost digital devices such as the Arduino, Makey Makey kits, and 3-D printers has undoubtedly fueled this movement. Students can use apps on their phones or tablets to control programmable robots, like Lego Mindstorms and Sphero, and the popular *Minecraft* gaming platform that allows kids of all ages to build and explore virtual worlds on their own and with others. Furthermore, there is a renewed interest in teaching programming and computational thinking (see Chapter 6), with the main intent to make computing and the associated *thinking* skills more achievable for students of all ages.

With the availability of low-cost components and sensors that send data to a managing application, students can, for the first time, build, as well as use, inexpensive devices that allow them to collect data, and transmit and receive information from devices that are interconnected over the Internet. Entire schools are able to take advantage of the Internet of Things, using interconnected devices to not only conduct research but to also perform functions as diverse as monitoring attendance and controlling heating and ventilation systems (Educause Learning Initiative, 2014).

Technology has finally developed to the point where the focus can be on supporting the learning process. And thus, the conversation becomes one about how technology can provide assistance to teachers and students in achieving their learning goals. This new focus on technology-enabled pedagogy, on the creation of powerful learning environments enabled by technology, is the identifying characteristic of this most current stage in the evolution of technology integration in the schools. There are, however, barriers that remain. Access to digital devices still remains uneven, and in some schools, teachers also need support in developing skills that allow them to effectively implement these powerful tools for learning. As you enter the teaching profession, we hope you will find creative ways to overcome these barriers and achieve the current goal for technology integration in education—the inclusion of relevant technologies as integral and natural contributors to the entire educational process.

1-1b Summary of Technology Integration in Teaching and Learning

So what have we, as educators, learned as we have moved through the various phases and stages of technology integration in education? We know that teachers cannot be

APPLY to Practice

Technology in Education

1. Reflect on your own experiences using technology for learning. What technologies were used when you were a student? How were they used?
2. How were technology-related skills taught to you as a student? What kinds of skills were emphasized?
3. What skills and knowledge do you already possess to help you meet the challenges of effectively integrating technology into instruction? How did you learn those skills?
4. Discuss your experiences with your peers. Do you have similar experiences? What differences exist?

replaced with technologies. Instead, the role of the teacher has changed over time as teachers have benefited (maybe even just recently) from having powerful tools and ample resources available to support their teaching (see Table 1-1). New technologies make it easier to incorporate new learning theories and pedagogies such as personalized learning, deeper learning, knowledge construction, collaborative learning, and both design and computational thinking in our classrooms. Notions such as "teachers as facilitators" or "students as active learners" can be implemented with the assistance of new technologies. Technology tools allow access to expanded resources and have the capacity to free students and teachers from mundane tasks so that they can focus on activities that promote greater collaboration, in-depth study, and critical-thinking skills. Now, educational software programmers and developers build their products based on well-founded learning theories and pedagogies. Of course, some software may be consistent with your teaching style and classroom goals but others may not be. As you seek to integrate technologies in your future classroom, you must find the digital tools and resources that best support your curriculum, your teaching style, and your students.

1-2 The Standards Movement

The standards movement in education heavily influences the way in which technology proficiency is defined. Prior to 1983, there was little discussion of standards in education in the United States. In 1983 the report titled, *A Nation at Risk* (National Commission on Excellence in Education) was published, and in the eyes of many, the modern standards movement began. Among other things, this report included two goals directly related to academic achievement. One goal indicated that students in grades 4, 8, and 12 would demonstrate competency in English, mathematics, science, history, and geography by the year 2000. The other goal stated that U.S. students would be first in the world in science and math achievement by the year 2000. To determine the criteria for compliance with these goals, minimum standards were needed in many content domains where few, if any, had existed previously. And so, beginning in 1983, and continuing through 1999, efforts were undertaken by the national professional organizations in all the major content areas (English, mathematics, science, etc.) to create a set of curricular standards for their specific disciplines.

Over the past 20 years, the standards created by the various professional organizations have influenced the creation of state-specific content standards. Because of the

APPLY to Practice

Locating Content Standards

1. Are there state content standards that you must meet? Locate and review the standards.
2. Does your national professional organization have a recommended set of content standards? If so, locate its website and review its standards.
3. Compare the two sets of standards. How are they similar? Different?
4. Compare your content standards with the standards for two of your fellow students in different fields. How do your standards compare with theirs?

wide diversity in state standards, the National Governors Association Center for Best Practices and the Council of Chief State School Officers coordinated efforts to develop a common core of academic standards (Common Core State Standards Initiative, 2017) that influenced the development of college- and career-ready standards in most states. Currently, as a classroom teacher, it is likely that you will focus primarily on developing lessons that meet your state content standards, as these are the criteria on which your students will be expected to demonstrate proficiency—usually on high-stakes assessments.

The development of technology standards started a little later. In 1998, ISTE released the National Educational Technology Standards for Students (NETS-S). Since then, ISTE has developed multiple sets of technology standards, including the National Educational Technology Standards for Educators (formerly, NETS-T) and for Administrators (NETS-A). The chapters in this book address the most recent ISTE Standards for Educators released in 2017 (see Figure 1-4); however, you will also learn about the Standards for Students (see Figure 1-5) as the educators' standards require that you develop those skills in your students.

Although the first set of standards, released in 1998, focused on learning to *use* the technology itself, the most recent versions of the student and teacher standards focus on *learning* and the use of technology as a powerful tool in that process (ISTE, 2017b). And as technologies have become more powerful, there has been a shift in focus from teacher-driven to student-driven pedagogical practices. As you will recall, this focus on technology-enabled learning reflects the fifth and current phase in the movement toward the use of digital technologies as integral parts of the teaching/learning environment.

Furthermore, the most recent ISTE Standards for Educators recognize teachers as active participants in a professional community of practice. With the use of the term *educators*—rather than *teachers*, as in the 2000 and 2008 National Educational Technology Standards for Teachers (NETS-T)—ISTE acknowledges the role that paraprofessionals, administrators, after-school program personnel, and others play in the education of K–12 students. ISTE further acknowledges that teachers must be empowered professionals, as well as learning catalysts in the classroom. As **empowered professionals**, teachers engage in continual learning, seek opportunities to be teacher-leaders, and practice good citizenship in modeling socially responsible behaviors. As **learning catalysts**, teachers collaborate with colleagues and students to improve their practice and solve problems, design learning activities and environments that empower students, facilitate learning in their classrooms, and analyze and use data to inform their instruction and support students in achieving their learning goals.

Because you are undoubtedly reading this book to learn new information and skills, we will begin our discussion of the 2017 Standards for Educators by focusing on teachers as learners. In Chapter 2, we introduce you to our self-directed learning model, the GAME plan, used throughout this book. Remember, one of our primary goals is to help you become a self-directed learner who can successfully navigate the

ISTE STANDARDS FOR EDUCATORS

Empowered Professional

1. Learner

Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning. Educators:

a. set professional learning goals to explore and apply pedagogical approaches made possible by technology and reflect on their effectiveness.
b. pursue professional interests by creating and actively participating in local and global learning networks.
c. stay current with research that supports improved student learning outcomes, including findings from the learning sciences.

2. Leader

Educators seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning. Educators:

a. shape, advance and accelerate a shared vision for empowered learning with technology by engaging with education stakeholders.
b. advocate for equitable access to educational technology, digital content and learning opportunities to meet the diverse needs of all students.
c. model for colleagues the identification, exploration, evaluation, curation and adoption of new digital resources and tools for learning.

3. Citizen

Educators inspire students to positively contribute to and responsibly participate in the digital world. Educators:

a. create experiences for learners to make positive, socially responsible contributions and exhibit empathetic behavior online that build relationships and community.
b. establish a learning culture that promotes curiosity and critical examination of online resources and fosters digital literacy and media fluency.
c. mentor students in the safe, legal and ethical practices with digital tools and the protection of intellectual rights and property.
d. model and promote management of personal data and digital identity and protect student data privacy.

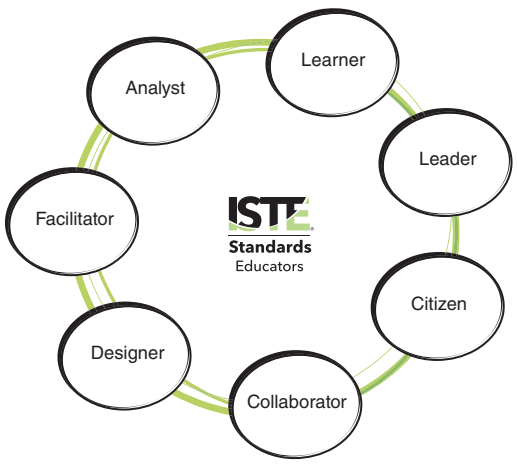


Figure 1-4
The 2017 ISTE Standards for Educators

Source: ISTE Standards for Educators, ©2017, ISTE® (International Society for Technology in Education), iste.org. All rights reserved.

Learning Catalyst

4. Collaborator

Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas and solve problems. Educators:

a. dedicate planning time to collaborate with colleagues to create authentic learning experiences that leverage technology.
b. collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues.
c. use collaborative tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and globally.
d. demonstrate cultural competency when communicating with students, parents and colleagues and interact with them as co-collaborators in student learning.

5. Designer

Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability. Educators:

a. use technology to create, adapt and personalize learning experiences that foster independent learning and accommodate learner differences and needs.
b. design authentic learning activities that align with content area standards and use digital tools and resources to maximize active, deep learning.
c. explore and apply instructional design principles to create innovative digital learning environments that engage and support learning.

6. Facilitator

Educators facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students. Educators:

a. foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings.
b. manage the use of technology and student learning strategies in digital platforms, virtual environments, hands-on makerspaces or in the field.
c. create learning opportunities that challenge students to use a design process and computational thinking to innovate and solve problems.
d. model and nurture creativity and creative expression to communicate ideas, knowledge or connections.

7. Analyst

Educators understand and use data to drive their instruction and support students in achieving their learning goals. Educators:

a. provide alternative ways for students to demonstrate competency and reflect on their learning using technology.
b. use technology to design and implement a variety of formative and summative assessments that accommodate learner needs, provide timely feedback to students and inform instruction.
c. use assessment data to guide progress and communicate with students, parents and education stakeholders to build student self-direction.

Figure 1-4
(continued)

Professional Resource Download

constantly changing environment of technology integration. We then discuss the various roles of teachers as learning catalysts. In Chapters 3 through 9, you will learn to leverage technology to support effective teaching and learning as we address the role of teachers as designers in Chapters 3 and 4; facilitators in Chapters 5, 6, 7, and 8; analysts in Chapter 9; and collaborators in Chapter 10. We then return to our discussion of teachers as empowered professionals as we address the responsibilities of teachers as global citizens in Chapter 11 and as leaders in Chapter 12.

1-2a The Value of Standards

The information presented so far provides a glimpse of the roles of government and professional organizations in the development of standards. However, except for their ability to address legislative and political requirements, not much has been said about

ISTE STANDARDS FOR STUDENTS

1. Empowered Learner

Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. Students:

a. articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.
b. build networks and customize their learning environments in ways that support the learning process.
c. use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
d. understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

2. Digital Citizen

Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. Students:

a. cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.
b. engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.
c. demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.
d. manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

3. Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. Students:

a. plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
b. evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
c. curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
d. build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

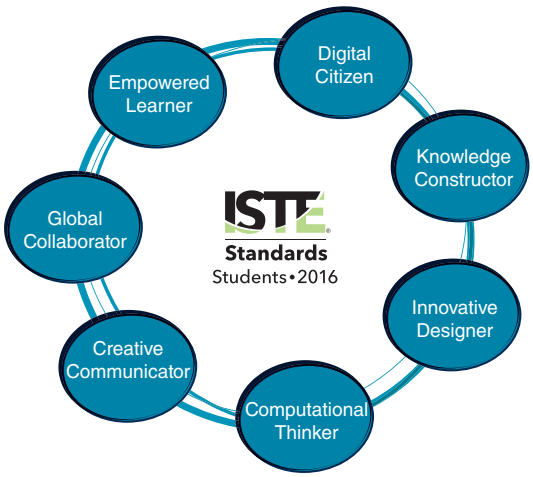


Figure 1-5
The 2016 ISTE Standards for Students

Source: ISTE Standards for Students, ©2016, ISTE® (International Society for Technology in Education), iste.org. All rights reserved.

4. Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. Students:

a. know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
b. select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
c. develop, test and refine prototypes as part of a cyclical design process.
d. exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

5. Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. Students:

a. formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
b. collect data or identify relevant data sets, use digital tools to analyze them and represent data in various ways to facilitate problem solving and decision making.
c. break problems into component parts, extract key information and develop descriptive models to understand complex systems or facilitate problem solving.
d. understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

6. Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. Students:

a. choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
b. create original works or responsibly repurpose or remix digital resources into new creations.
c. communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
d. publish or present content that customizes the message and medium for their intended audiences.

7. Global Collaborator

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:

a. use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.
b. use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
c. contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
d. explore local and global issues and use collaborative technologies to work with others to investigate solutions.

Figure 1-5
(continued)

Professional Resource Download

the *value* of standards. Although many reasons can be advanced for the development of standards, the main reasons include:

- Standards provide a common set of expectations.
- Standards clarify expectations.
- Standards raise expectations. (McREL, 2004)

So, technology standards, such as those from ISTE, provide a common set of *expectations* across states and localities. Moreover, they *clarify* how educators can support student learning with technology. Finally, they *raise expectations* by creating an awareness of what can be accomplished. When standards work as intended, they help us achieve first-rate quality—in services, products, and teaching. Throughout this book the ISTE standards are used to provide a common set of expectations, as well as to clarify and raise the expectations regarding the skills you should obtain while developing the competencies needed to leverage technology within the classroom.

In general, standards refer to a degree or level of requirement, excellence, or attainment expected of an individual or organization. In more simple terms, standards are **criteria**. Criteria define what is expected, such as the content you are expected to teach. As a teacher, you will be most concerned with meeting standards that relate to how well you address the requirements of your curriculum, how well your students perform, and—specific to this textbook—how well you are able to leverage technology in your teaching. However, it is not enough to look only at criteria when discussing standards.

What makes standards different from other types of quality expectations are the additional factors of **compliance** and **consequences**. Compliance refers to who is subject to the standards and on what basis. Demonstration of compliance can occur in a number of ways including observation by an administrator or other teacher, documenting your proficiency in a portfolio, or perhaps even passing a test. Standards typically have consequences associated with compliance or noncompliance. These consequences indicate what happens if you do or don't meet the expectations. For example, failure to comply with standards may result in mandatory remedial instruction, delays in pay raises, or in limited employment opportunities. Being compliant may help you get a job or attain benefits such as tenure, monetary rewards associated with reaching higher levels on your career ladder, or the opportunity to teach different courses or work with different students. Although most states are likely to require teachers to meet a set of technology standards, ISTE notes that it developed the 2017 Standards for Educators to be more aspirational than evaluative. As such, the intent of this book is to help you meet ISTE's 2017 Standards for Educators as you aspire toward excellence in teaching with technology.

1-3 The Technology Integration Continuum

The overarching goal of the ISTE standards is to enable teachers to create dynamic learning experiences that integrate our understanding of how people learn with the relevant technological tools that can support teaching and learning. To create these kinds of learning experiences, effective technology integration requires more than simply introducing computers and related technologies into the classroom. To **integrate** means

APPLY to Practice

Technology Standards

1. Identify the technology standards that your state expects teachers to meet.
2. How do they align with the ISTE Standards for Educators used in this book?

to combine two or more things to make a whole; when we integrate technologies into instruction, we make them an integral part of the teaching and learning process. **Technology integration** requires changes to many instructional components including:

- what resources are used;
- what roles the teacher performs;
- the nature of the instructional activities; as well as
- what roles students play.

Based on ISTE's definition, **new learning experiences** are ones in which teachers and students work together to address the requirements of the curriculum while still taking into account individual student needs, interests, and preferences. New information is readily linked to students' prior knowledge. Students are also given some degree of choice in terms of the ways they receive and process information and demonstrate their learning. Instructional activities rely on teaching methods that encourage high levels of thinking and creativity and that allow students to collaborate and communicate—both with other students and teachers—as well as experts outside of the classroom. Students are encouraged to solve authentic problems drawn from real-world situations (e.g., How can we improve our city so that everyone benefits? Why should kids care about the price of gas?) within the context of one specific content area (social studies, mathematics) or across content areas. This type of authentic learning requires students to identify and describe a real-world problem, relate it to prior knowledge, develop recommendations to solve the problem, select strategies to pilot those recommendations, and monitor and evaluate how well their strategies worked in solving the problem. Supporting teaching and learning in this type of authentic environment are resources and technologies (Internet resources, databases, spreadsheets, presentation software, and many others) that allow students to work as professionals in an information-based world, support them across varied levels of need, and build and demonstrate both content and technology proficiencies.

The type of learning experiences you create in your classroom will influence the types of technologies that you and your students use (see Photo 1-3). It will also affect *how* you and your students use these technologies. For example, if teachers use presentation software to project to a screen what they formerly wrote on the chalkboard, simply adding computer technology doesn't change their teaching approach to a more powerful one. What is most important is *how* the technology is used. A more powerful approach may involve a group of students working collaboratively with this same presentation software to create a slideshow that includes pictures of artifacts or charts and graphs that summarize research they have completed, manipulating the data and information on the screen itself, and sharing it with the class to create a digital repository that others can search at any time from any device. Although the same technology is being used in both classrooms, the *way* it is being used is quite different.

Photo 1-3
Technology can help teachers develop new learning environments and experiences.

1-3a Stages in Technology Integration

A number of researchers (e.g., Dwyer, Ringstaff, & Sandholtz, 1991) have documented the developmental stages that teachers go through as they move from novice technology users to those capable of using technologies to create meaningful learning experiences. As reflected in our *Stories from Practice*: *The Write Way,* teachers initially focus on learning the new technology and using the technology to support traditional instruction. In later stages, teachers begin to develop new approaches

STORIES *from Practice*

The Write Way

In the late 1990s, when computers became a ubiquitous educational enterprise for teachers, I distinctly remember forcing myself to lay my beloved journal aside and compose directly on the computer. The transition was easier than I had anticipated; it saved time, and the result was a satisfyingly slick, professional rendering. Yet, like most changes, nostalgia for my former writing method gnawed at me. I missed the messy pages of my initial drafts with their imperfect phrases and crossed out lines. In those days, you could literally SEE your writing process as it unfolded. Now, most of the "work" involved is whisked away by a simple highlight and delete, and the first draft looks as neat and clean as its final revision.

Similarly, and again because of new technologies, the manner in which my student writers share their work has shifted as well. My students' writing workshops have evolved from what used to be a very public, collective presentation to the current private, more personal one. I am a firm believer in student choice—especially when it comes to individual writing—thus, writing workshop options are considerations made by the writer, not the teacher. In the past, a few students would begin sharing their first drafts in a large group with a verbal response, then a few more would opt to share in a small group aloud, and from there, those who were shy or less confident in their writing would choose to share in a small group, reading silently and receiving private feedback.

With the advent of omnipresent, handheld computers (also known as cell phones), our student population has, paradoxically, become more private. The more connection they have with the chaotic, yet stimulating cyberworld, the less time—and practice—they have with interpersonal, live communication. My student, Kylie, explains, "I think because everyone has their cell phone out 24/7, kids don't like the idea of working face-to-face anymore."

Another student, Cody, pipes in with, "Kids are insecure about their own writing because of bullying. They are more afraid to be judged."

Katie adds, "I prefer online because I can't take face-to-face criticism. It's easier if it's online."

And Ben says, "It's already on the computer and everyone has access to it, so why not just read it there?"

They have a point. After all, I would not bust out the old reel-to-reel technology of yesteryear in my Film Appreciation class, so why not use the inventive tools available to us when it comes to writing and responding? The upside is that students who were formerly reticent to comment or share suddenly have a voice they are willing to use. Both Office 365 and Google Docs give responders the ability to make comments and suggestions in the margin of the composition documents. Likewise, blogs and learning management systems' discussion boards allow electronic interaction with more convenience and less time constraints than face-to-face feedback sessions. The once voiceless and silent students are now more active participants in a system that allows them more anonymity, less exposure, and more confidence to respond.

So, although I am, yet again, longing for "the way things used to be," I also welcome the way writing workshop has changed. For now, it is the write way.

Source: Susan Swift, Hempstead High School, Dubuque Community Public Schools, Iowa.

to teaching and learning that make the most of the technology available to them. Teachers no longer try to adapt instruction to technology but instead adjust the fundamental nature of their instruction to enable new learning activities not possible without the technology.

A number of technology integration continua reflect similar ideas. For example, the four phases of the SAMR model—substitution, augmentation, modification, and redefinition—categorize the progression that teachers may follow when adopting new technologies for teaching and learning (Puentedura, 2009). You may work for one of the many school districts that have developed their own frameworks to illustrate how teachers progress through various stages as they become more comfortable, and sophisticated, in the use of technology for teaching and learning.

In this book, we will use the four-stage continuum that accompanied the 2008 ISTE Standards for Teachers—beginning, developing, proficient, and transformative. Following are generalized descriptions of these four stages using the lens of the four essential components identified earlier (e.g., resources, teacher role, instructional activities,

APPLY to Practice

Classroom Observations

Find one or more teachers to observe or view on video. Describe how their technology uses support the four common components of instruction identified in the previous section. Consider the following questions:

1. Use of resources: How well are they matched to the instruction? What role do technology-based resources play?
2. The teacher's role: What roles do teachers play in these classrooms? Do they lead instruction or do they enable students to develop higher-order skills through collaborative problem solving? Does technology use replicate traditional seat-based activities or does it support diverse learning styles and preferences in unique settings?
3. Nature of instruction: Do students encounter well-structured or complex problems? Are assessments norm-based or do they allow for reflective responses and accommodate a variety of learning preferences? Is technology central to the instruction?
4. Students' role: On whom is the learning focused? How are the students engaged? How are individual differences supported and nurtured? How much voice and choice are students allowed? How does technology support and motivate student activities?

students' role). Notice how the actions of the teacher and students change as we move through the stages, as well as how resources are used and activities are structured. However, be aware that teachers and activities may exhibit characteristics across stages. As you read the descriptions of the four stages, think about where your former teachers and colleagues might fall on the continuum. Where do you think you might be?

Characteristics of the Beginning Stage

- Teachers select and use technologies and other *resources* that support student learning experiences, but classroom instruction may still depend heavily on chalk or greaseboards, textbooks, workbooks, and worksheets to support lecture, recitation, and seatwork.
- *Teachers* research and discuss strategies students can use to promote knowledge construction and demonstrate critical thinking. They monitor safe, ethical, legal, and healthy use of technology and information resources.
- Teachers design *instructional activities* by using or modifying existing learning resources to collect information and create student products. Teachers select and use formative and summative assessments to inform teaching and learning.
- *Students* use technology tools to research and collect information.

Characteristics of the Developing Stage

- Teachers plan, manage, and facilitate student understanding of technologies and other *resources* best suited to support specific learning experiences.
- *Teachers* facilitate and guide students as they employ strategies to construct knowledge and promote critical thinking; they model safe, ethical, legal, and healthy use of technology and information resources and help students address threats to security of technologies, data, and information.
- Teachers adapt or create *instructional activities* that allow students to collect and report information through a variety of products and formats. Teachers

develop and conduct formative and summative assessments to inform teaching and learning.
- *Students* use technology tools to collect information, synthesize, and create new information in projects guided by their teachers. They explore issues of individual interest related to their learning.

Characteristics of the Proficient Stage

- Teachers demonstrate and model effective use of a variety of existing and emerging technology-based *resources* to encourage students to engage in a range of relevant learning experiences.
- *Teachers* model critical thinking and knowledge construction and enable students to demonstrate creativity and innovation. Teachers advocate for and effectively instruct students in the safe, ethical, legal, and healthy use of technology and information resources including emerging policies and practices related to issues such as security, intellectual property, and personal rights.
- Teachers design and customize *instructional activities* in response to students' learning styles, preferences, and abilities, so that students develop questions, propose solutions, and elicit feedback on their learning. Teachers co-plan with students various opportunities for them to demonstrate skills and knowledge to adapt future teaching and learning opportunities.
- *Students* use technology in support of collecting and synthesizing information, developing and demonstrating critical thinking, and solving authentic problems through the creation of projects they propose. Students use technology to plan, manage, and reflect on their own learning.

Characteristics of the Transformative Stage

- Teachers engage with students to explore and determine appropriate uses of existing and emerging technology-based *resources* so that students may effectively plan, manage, and evaluate their learning experiences.
- *Teachers* collaborate with and involve students as lead learners in student-driven activities that promote innovation and explore complex issues. They engage students as active participants in the safe, ethical, legal, and healthy use of technology and information resources by encouraging them to establish policies and procedures for their use and determining methods to address misuse.
- Teachers collaborate with students to identify and develop personalized *instructional activities* that allow students to formulate, evaluate, and test hypotheses to address complex problems that address real-world local and global issues with their teachers, other students, and outside experts and share their information for real-world application. Teachers engage students in the development and analysis of various opportunities to demonstrate skills and knowledge to orient future teaching and learning opportunities toward areas necessary for greatest student success.
- *Students* collaborate and communicate with their teachers, other students, and experts to select and use technology tools that align with learning preferences, styles, and content requirements to address real-world, complex problems with multiple answers or solutions. Students routinely monitor, evaluate, and adjust their own learning strategies and thinking.

The classroom descriptions presented in Tables 1-2 through 1-5 illustrate each of the four aspects of effective integration as implemented by teachers at both early and later stages of proficiency in technology integration. As you read the descriptions of these classrooms, consider how the two teachers profiled in each table differ in their roles, their use of technology resources, the nature of their instructional activities, and the roles of their students.

Table 1-2 Use of Technology Resources

The following classroom scenarios demonstrate integration practices of teachers at both *early* and *later* stages of technology integration proficiency. As you read them, think about the *resources* available and how the teachers actually used them. How well are they matched to the instruction? What role do technology-based resources play?

Wallace McManus is introducing the scientific method to his fifth grade class. He has used his computer to create a worksheet for his students that identifies steps in the process, including formulating and testing hypotheses. Learning stations are set up around the room where students find containers of water, several dry and wet ingredients, a heating element, and some ice. Wallace plans to have the students propose hypotheses about how the different materials will react to each other and at different temperatures. The students will write down observations in their lab notebooks as they walk around the room and later record their responses on their worksheets. Wallace knows this is a good lab for students to experience, although inevitably some of them tend to be kind of messy while completing the various activities.	Cindy Garcia-Stamos is planning a science lab for her fifth grade students. She and her students have downloaded a map and satellite images from a website of the area surrounding their school. She has asked her students to develop a hypothesis about the potential effects of the proposed four-lane highway on the natural inhabitants of the grass, forest, and wetland areas near their school. She and her students collected soil and water samples during a recent field trip to key areas marked on their maps. They also took digital photos of the animals and plants in the areas they visited. The class will use several different probes to gather data from the samples and will track changes when new elements from the road development are added. Students are working in teams representing various stakeholder groups, including developers and business people in the community, local residents, and administrators at the school. They will use Internet resources to find additional data and then to develop multimedia presentations to share their results with the rest of their class and post online for their parents and other community members to review. Students will propose at least one hypothesis about the highway development project and will use the data they collected and analyzed to support or refute that hypothesis.

Table 1-3 The Teacher's Role

The following scenarios illustrate the approaches of teachers at both *early* and *later* stages of technology integration proficiency. What roles do *teachers* play in these classrooms? Do they deliver instruction or do they use the content to engage students in collaborative problem solving and higher-order thinking? Is technology used to replicate traditional seat-based activities or does it support diverse learning styles and preferences in unique settings?

Principal Novella Mayberry is observing an American history lesson on the economic and political forces that led to the Great Depression. She and the teacher she is observing, Lynette Haines, have been friends and colleagues for a good part of their careers. Lynette's students are always well behaved and quiet as they furiously scribble down notes during her presentation. Novella notes that her friend is using presentation software to support her lectures and is fairly sure that the information is based on the same lecture notes she has used in the past. There's little interaction between Lynette and her students, or among the students themselves. When Lynette asks the students questions, they usually answer by nodding their heads. The class comes to a close as Lynette gives the next reading assignment and distributes a worksheet she has photocopied to the students.	The noise level in Shanika Wallace's seventh grade class is pretty high; students are scattered around the room in small groups while they work on a local history project. "It's the hum of learning," thinks Shanika, who serves in the role of project manager, checking on the progress of one team as other groups of students are busy sharing ideas, asking each other questions, and monitoring timelines and work progress. Shanika and her students began this multiday lesson by developing a rubric that would be used to assess the quality of both the content and the design of the project. This time, Shanika allowed the students to create their own teams of up to four students to work on different aspects of the project. Some students are editing short digital movies of interviews conducted with their parents or neighbors, while others are taking digital pictures or scanning artifacts to help document how their community has changed over time. All students are required to respond to prompts that Shanika posts on the class blog every day. When they're done with this unit, the movies, pictures, and documents will be housed on an oral history web page, and the students will be in charge of advertising the site through print, public-access television, and social media.

Table 1-4 Nature of Instruction

As you read the following two classroom scenarios, illustrating teachers at both *early* and *later* stages of technology integration proficiency, focus on the *nature of the instruction* described in each. What kinds of problems do students encounter? Are they well-structured or ill-structured? What kinds of assessments are used? Norm-based or criterion-based? Closed-ended or open-ended? How integral is technology to the instruction?

Steven Tucker is head of the math department at Central High School and is proud of how much he has taught himself about computers and technology. He was one of the first teachers in his school to use presentation software and quickly learned on his own how to use the many animations, sounds, and slide backgrounds to spice up his lectures. He has typed all of his lecture notes, for each of the three different classes he teaches each year, in separate word-processing documents and has organized them in chronological sequence in his folder on the school's file server. He has also typed all of his worksheets and has created folders for the students in each of his classes. He feels that teaching has gotten easier, because he can easily pull up his lecture notes, show the corresponding presentation to his class, and have them access their homework assignments from the file server. They just print them out and turn them in. No more illegible student handwriting to decipher. He even uses scannable test forms for his tests and that is saving him even more time.

The students in Brenda Williams' geometry class are excited and happy after their presentations from a semester-long project that has required them to think about how math is used in daily life. The goal of the project was to contribute to the design of a new library being built in the neighborhood. Students used the Internet to measure the irregularly shaped site for the proposed library. Following this, students created scale drawings of a possible building including parking, outside seating, and access for people with disabilities using geometry software. They researched different kinds of furniture and equipment for use within the library and each team developed a proposal and scale model for how one of the sections could be organized and used. The students calculated material costs using an online calculator that Brenda found and then created a spreadsheet with charts outlining those costs and providing different cost scenarios. The class worked in teams of two or three students, and each team presented their ideas to two of the library project's architects, who both reported they got new ideas they were going to bring back to their team to consider.

Table 1-5 The Students' Role

As you read the following scenarios, illustrating practices of teachers at both *early* and *later* stages of technology integration, think about how the *students* are engaged in the instruction. On whom is the learning focused? How are the students invested in the learning? How are individual differences supported and nurtured? How does technology support and motivate student activities?

Amy Ferrell's cell phone startles her and she jerks up in her seat. She keeps forgetting to turn off the ringer when she gets to school and it's now ringing deep inside her backpack. She fumbles to find the phone in the darkened class while only her best friend Laurie notices and gives her a smirking grin. Amy and Laurie are in English and are watching a movie version of *West Side Story,* which has taken several class periods. She and her classmates poke fun at the costumes, the funny language, and all the singing and dancing, but at least she understands this language better than when they read *Romeo and Juliet,* and watched that movie. She knows she's supposed to understand and respect the works of Shakespeare, but it was hard reading. Some of the students were picked to read some of the scenes in class, like that famous balcony scene that had those lines she didn't realize were from Shakespeare—"wherefore art thou?" and "a rose by any other name"—but she didn't want to read the stilted language in class and didn't volunteer. At least her teacher has let the class choose between watching this movie or a production of the real play. She turns off her phone and slinks back down into her seat to continue watching the movie.

Butch Simmons had never really been interested in English and hadn't looked forward to studying *Hamlet,* but his teacher, Mr. Fordham, took a different approach. They still had to read parts of the play, but then Mr. Fordham asked the students how the play related to their current lives or current events. He then encouraged them to consider ways to present ideas from the play to a modern audience using current media. Of course, some of the drama kids acted out scenes from the play with modern characters, but Mr. Fordham had them record the scenes with their cell phones and then they posted the short videos as a web series on their class YouTube site. Some students used Twitter or Instagram to post scenes. During a conference with Mr. Fordham, Butch explained that he didn't see *any* similarities between what happened in Hamlet and the events in his own life, but then Mr. Fordham asked him if any of the *Star Wars* movies (his favorite movies of all times) had themes that were similar to those that appeared in Hamlet. What an interesting question! Butch immediately became excited about researching that idea and is now working on a blog post for the class's website, which identifies the important influence of the play on the *Star Wars* movies.

DGLimages/Shutterstock.com

Photo 1-4
Using new and emerging technologies, such as virtual reality, will help you provide innovative and transformative learning environments for your students.

If you suspect you're at one of the early stages in technology integration, don't worry! If you are currently using this textbook as part of a typical college course, you may expect to reach one of the higher stages by the end of the course, even if you entered without prior knowledge of how to use digital technologies in the classroom. If you are taking this course early in your college career and continue to use your skills throughout your education courses, you can expect to be comfortably situated in the "proficient" stage by the time you graduate. Wouldn't it be wonderful if you were at that stage as you entered the classroom? And with more experience, we're confident that you will be one of those dynamic teachers who functions on a day-to-day basis in the transformative phase.

To become and remain a creative, transformative teacher, you will need to continue to learn about new and emerging technologies throughout your career. This book, although organized around the 2017 ISTE Standards for Educators, is, above all, intended to help you identify the learning goals you have for yourself and your future students. Furthermore, it is designed to help you decide which technologies provide the best tools to reach those goals. Ultimately, the decision regarding how to use technology in the classroom is yours to make.

Chapter Summary

In this chapter we reviewed the history of technology integration within education. You were introduced to the ISTE Standards for Educators and encouraged to identify the technology standards that you will be expected to meet throughout your professional preparation and practice. You were introduced to stages of technology integration and asked to consider how different classroom practices (use of resources, role of teacher and students, and nature of instructional activities) change as one moves through the stages.

Throughout this book, you will consider how you will integrate technology into your own teaching. You'll think about how students will interact with technologies,

the resources you will provide, the instructional activities you will use, and the role you will assume as a teacher in a technology-rich classroom. As a beginning teacher you may face some challenges—every teacher does. But as part of the first generation of teachers to enter the teaching profession already comfortable with computers and other digital technologies, you are probably more prepared than we were as beginning teachers. We believe that you are ready to go to the next stage of technology integration within education: using technology as a natural part of the learning process, for both you and your students. Our goal is to help you develop innovative technology-enabled pedagogies to reach the goals you have set for yourself and your students.

Key Terms

compliance (p. 19)
computer literate (p. 6)
consequences (p. 19)
criteria (p. 19)
empowered professionals (p. 14)
information and communications technology (ICT) (p. 4)
information literacy (p. 9)
integrate (p. 19)
learning catalysts (p. 14)
new learning experiences (p. 20)
productivity applications (p. 8)
technologically literate (p. 6)
technology integration (p. 20)

YOUR PORTFOLIO

Your school or state may have a portfolio assessment system to which you are required to contribute. If not, in Appenidx B, you can learn about developing your own portfolio using common productivity tools such as word processors, web development software, and so forth. To document your learning for this chapter:

1. Identify the technology standards that you are expected to meet throughout your professional preparation and practice.

References

Allen, I. E., & Seaman, J. (2010). *Class differences: Online education in the United States, 2010,* www.onlinelearningsurvey.com/reports/class-differences.pdf.

Brown, J. L. (2017, March). How will the Internet of Things impact education? *EdTech Magazine*, edtechmagazine.com/k12/article/2017/03/how-will-internet-things-impact-education.

Common Core State Standards Initiative. (2017), www.corestandards.org/standards-in-your-state.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership, 48*(8), 45–52.

Educause Learning Initiative. (2014, October). 7 things you should know about the Internet of Things. *Educause*, library.educause.edu/~/media/files/library/2014/10/eli7113-pdf.pdf.

Hour of Code. (2013). Computer Science Education Week 2013: "Hour of Code" campaign. Seattle, WA: Author, https://csedweek.org/files/HourofCode-1pager.pdf.

International Society for Technology in Education (ISTE). (2008). *About ISTE*. Eugene, OR: Author, www.iste.org/about-iste.aspx.

International Society for Technology in Education (ISTE). (2016). *ISTE standards for students*. Eugene, OR: Author.

International Society for Technology in Education (ISTE). (2017a). *ISTE standards for educators*. Eugene, OR: Author.

International Society for Technology in Education (ISTE). (2017b). *ISTE standards for educators: A guide for teachers and other professionals*. Eugene, OR: Author.

Jonassen, D. H. (1996). *Computers in the classroom: Mindtools for critical thinking*. Columbus, OH: Merrill/Prentice Hall.

Lehmann, C., & Chase, Z (2015). *Building school 2.0*. San Francisco: Jossey-Bass.

Mid-continent Research for Education and Learning (McREL). (2004). Content knowledge, www2.mcrel.org/compendium.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: Government Printing Office.

National Education Association (NEA). (n.d.). *Guide to teaching online courses*, www.nea.org/assets/docs/onlineteachguide.pdf.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York: Basic Books.

Partnership for 21st Century Skills. (2004). *Learning for the 21st century: A report and MILE guide for the 21st century*. Washington, DC: Author.

Partnership for 21st Century Skills. (2007). *Framework for 21st century learning*. Washington, DC: Author.

Picciano, A. G., & Seaman, J. (2007). *K–12 online learning: A survey of U.S. school district administrators*. Sloan Consortium, www.onlinelearningsurvey.com/reports/k-12-online-learning.pdf.

President's Committee of Advisors on Science and Technology. (1997). *Report to the President on the use of technology to strengthen K–12 education in the United States*. Washington, DC: Panel on Educational Technology.

Puentedura, R. R. (2009). *As we may teach: Educational technology, from theory into practice*, www.hippasus.com/rrpweblog/archives/000025.html.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

U.S. Department of Education. (2000). *E-learning: Putting a world-class education at the fingertips of all children*. Washington, DC: Author.

U.S. Department of Education, Office of Educational Technology. (2010). *Transforming American education: Learning powered by technology*. National Education Technology Plan, 2010, www.ed.gov/technology/netp-2010.

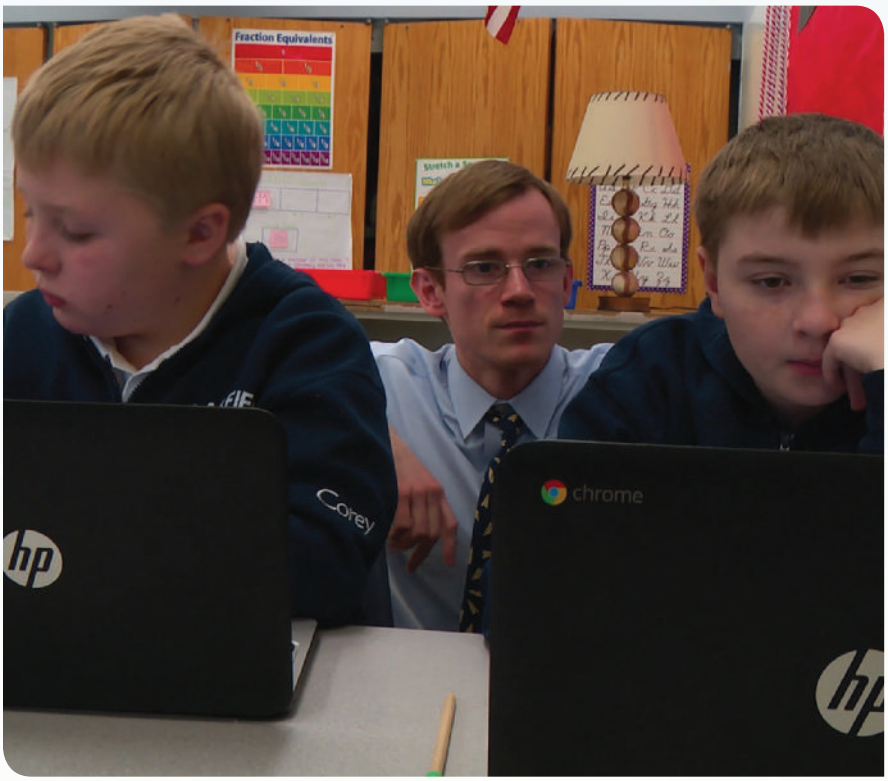
U.S. Department of Education, Office of Educational Technology. (2016a). *Advancing educational technology in teacher preparation: Policy brief*, tech.ed.gov/teacherprep.

U.S. Department of Education, Office of Educational Technology. (2016b). *Future-ready learning: Reimagining the role of technology in education*. 2016 National Education Technology Plan, tech.ed.gov/files/2015/12/NETP16.pdf.

U.S. Department of Education, Office of Educational Technology. (2017). *Reimagining the role of technology in education*. 2017 National Education Technology Plan Update, tech.ed.gov/files/2017/01/NETP17.pdf.

Teacher as Learner

2



LEARNING OBJECTIVES

After reading this chapter, you will be able to:

2-1 Apply the step-by-step actions of the GAME plan for self-directed learning.

2-2 Incorporate the GAME plan to set professional learning goals and reflect on progress in leveraging technology in support of students' learning.

2-3 Identify opportunities to develop personal and professional learning networks.

2-4 Explore current research to learn more about the effective use of digital tools and resources in support of student learning.

2-5 Develop a portfolio to document your implementation of best practices in the use of technology to improve student learning.

iste

ISTE Standards for Educators Addressed in Chapter 2

Standard 1: Learner

Educators continually improve their practice by learning from and with others and by exploring proven and promising practices that leverage technology to improve student learning. Educators:

1a. Set professional learning goals to explore and apply pedagogical approaches made possible by technology and to reflect on their effectiveness.

1b. Pursue professional interests by creating and actively participating in local and global learning networks.

1c. Stay current with research that supports improved student learning outcomes, including findings from the learning sciences.

Think back to the first time you used technology. Undoubtedly, a wide variety of technologies were in use from the very moment you were born. You probably began to watch television and videos at a very young age. You may have played computer games before you even entered school. You probably began to use word-processing software many years ago, perhaps in elementary school. What about the first time you searched the web? Do you remember the first time you communicated with a friend via email or sent a text? It's likely that your initial experiences with technology were somewhat different from your experiences today. And undoubtedly, your experiences today will be quite different from the ones you will have in the future.

This book is based on the premise that learning to teach, in general, and to teach with technology, specifically, are lifelong journeys. In fact, ISTE acknowledges this idea in the very first Standard for Educators. Standard 1 focuses on the empowered professional as learner, stating, "Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning." As a lifelong learner, much of your learning will be self-directed. That is, you will be responsible for locating learning opportunities and completing activities to meet your own learning goals.

In this chapter, we first introduce you to a self-directed learning model that we'll use throughout this book, a model we call the GAME plan. You will have the opportunity to set professional learning goals by reflecting on what you already know about leveraging technology in the classroom, as well as what you still need to know (Standard 1a). In subsequent sections, we discuss how you can take action to achieve your learning goals by participating in local and global learning networks (Standard 1b) and exploring current research that informs your teaching practice (Standard 1c). Finally, we introduce portfolios as a means to document your professional growth.

2-1 Self-Directed Learning: The GAME Plan

Gibbons (2002) defined **self-directed learning (SDL)** as "any increase in knowledge, skill, accomplishment, or personal development that an individual selects and brings about by his or her own efforts using any method in any circumstance at any time" (p. 2). You are self-directed anytime you learn a new skill (e.g., how to use new software or an app) or pursue more information about an intriguing topic (e.g., the features of a new cell phone that you are considering purchasing). As a future teacher, you will be directing much of your own learning, so it is important to think about how you learn best. Learners who "think about their thinking" and apply strategies to regulate and oversee their learning are often referred to as **metacognitive learners**. Many of the activities in this book require you to be both metacognitive and self-directed.

Self-directed, metacognitive learners engage in three key processes: planning, monitoring, and evaluating their learning activities (Ertmer & Newby, 1996). During the planning stage, you, as a learner, determine your individual learning goals. You identify what you already know about the task at hand and develop a plan of attack, otherwise known as a learning strategy. You determine what is required by the task, plan your study time, and if possible, arrange for the best learning conditions. During the monitoring stage, you take action to implement your plan, and as you engage in the task, reflect on whether you are making sufficient progress toward your goals. You determine whether the strategies you have chosen are working to accomplish the learning task effectively and efficiently. During the evaluating stage, you reflect on how well you have met your goals and determine whether you should modify your strategies for future learning tasks.

We have translated the recommendations for self-directed learning into the following four steps that we call the GAME plan:

1. Set Goals.
2. Take Action to meet those goals.
3. Monitor progress toward achieving goals.
4. Evaluate whether the goals were achieved and Extend your learning to new situations.

STORIES *from Practice*

Continual Learning

When I first entered the classroom four years ago, I was excited to learn what it would take to be a good teacher. My first year I discovered that whole-group instruction did not make much sense. I had students who struggled with concepts who then set the pace for the class when others were ready to start on practice activities. I found that students struggled with the application aspects of their homework because we never got to applications in class. I then began using "augmented reality," placing icons on their homework that they could scan to receive hints. I sadly stuck with this inefficient method of whole-group instruction my first year, all the while trying to figure out a new way, a different way to teach my students.

The next year I chose to focus my professional development on the use of specific technology tools. One workshop involved a video storage site, featuring embedded questions and logging student responses from those who had watched the lesson in real time. I was in love. I started right away recording videos for the next unit and reserving computer labs. I planned to have all of my students sit in the lab, watch the video, and take notes. Throughout, video questions popped up, allowing me to monitor students' comprehension of the material and assist struggling students. Often students did not want to watch the video and guessed, but they grew tired of my attempting to assist them, and began putting in more effort. There came a point where I had very few questions to answer for some topics. When students were finished working through the video, they could get started on their assignments. Whatever they did not finish would become homework, motivating students to work hard in class to understand the material.

This move to self-paced learning was encouragingly effective, but I felt I was spending too much time teaching basic skills rather than applications of the concepts and higher-order thinking. I continued researching and discovered the flipped classroom model, which would take the instruction outside of the class, giving the class time for applications and exploration.

During my third year my plan to flip my class had to be modified because of my upcoming maternity leave in November. I decided to continue with my videos and utilize my district's recently purchased learning management system (LMS) to provide instruction for my students and as a means to practice and assess their comprehension of the material. I began recording videos and creating assignments in the LMS. When I was finished, I had a video for every lesson of my absence and an assignment set to release at the start of each of my class periods, due in 24 hours. I feared I would run out of time, but two days after I was finished, my second son was born early. My students were required to be responsible and manage their time to be successful. Returning finals week, I was hit with the most defeating news. My substitute reported that most of my students refused to work and played games all class period, which was echoed by my more responsible students. Then I was called down to the principal's office. I remember sitting there already discouraged by the massive inbox of complaints I was receiving. At that point, the last thing I wanted on my first day back was to hear what I heard from my administrator. I was told that many students were not able to learn under my system and therefore they strongly recommended I reteach the material that the students "missed" during my absence. I walked out of the office ready to walk away from teaching. I had put a great deal of time and energy into the material that I left for my students, and due to user inaction, my responsible students were penalized by a need to repeat five weeks of material. Then at the return of the next semester, I began reteaching the material in a whole-group setting, to the complaints of my conscientious students who felt it was unfair and a waste of their time. I had vowed from that point on that I would never use a video lesson again and that whole-group instruction would be how I would teach until I retired from education. Fortunately, my technology coordinator had something else planned for me. In the spring, he signed me up for training to become a Dell-Certified Educator, and what I found there were teachers just like me—people willing and wanting to try new technology for the success of our students, and coaches excited to work with me to help me reach my teaching goals.

Year four was under way and I was prepared. I focused on three main things: communicating with parents and students about what their flipped class would look like and their responsibilities for being successful in the class; training my students to be organized with their schedules and understand their responsibility of being a student; and lastly never settling, with good always striving for greatness. I flipped my class after the first six weeks, giving time for my students to receive their school/district-supplied laptops, and ensuring that they were prepared for the flipped environment. Students watched their videos through the same video storage site I utilized my first year. During the class, questions were answered and students engaged in an activity over the material before beginning their homework assignment. Everything ran great during the first six weeks of implementation, which meant it was time to expand and figure out what the next step should be. Then in the next six weeks, I implemented choices incorporating different learning styles when it came to the activity or task that my students worked through in class before moving on to their homework assignment. Then the following six weeks I began incorporating unit-length projects to teach my students how to collaborate as teams and I am continuing to fine-tune how this should look in my class.

As I look toward my fifth year in education, I am excited for what lies ahead and for what I have accomplished thus far. It has been a journey, and the key to anything is to never give up, always strive to improve—not merely for your own benefit but for the future of your students.

Source: Natasha Antonini, Crowley High School, Crowley ISD, Texas.

Goals	Action	Monitor	Evaluate and Extend
• What do I want to know or be able to do? • What do I already know about the topic? • How will I know if I have been successful?	• What information do I need to meet my goal? • How can I find the information I need? • What resources are needed? • What learning strategy will I use?	• Am I finding the information I need? • What patterns are emerging from the information sources? • Do I need to modify my action plan?	• Have I met my learning goals? If not, should I modify my goals or my learning strategies? • What will I do differently in the future?

Figure 2-1
The GAME plan

Professional Resource Download

Throughout this book, we'll use the GAME plan to guide your self-directed learning activities (see Figure 2-1). The GAME plan enables you to customize your approach to learning tasks and to develop relevant skills that are important to you. Furthermore, the GAME plan is designed to prepare you for lifelong learning.

2-1a Using the GAME Plan to Learn about Technology-Enabled Pedagogical Strategies: An Example

The GAME plan requires you to think about and take steps to direct your learning process, and as such, is appropriate for exploring pedagogical strategies that leverage technology in support of student learning. Let's explore those ideas further to demonstrate the GAME plan technique.

Imagine that you are an elementary teacher. For the purpose of this example, let's say that you have heard about teachers who are using different types of coding lessons and materials in their elementary classrooms and so you selected a coding app and programmable robots as technologies that might be beneficial to your students' learning (see Photo 2-1). Evaluating a new teaching strategy such as this is actually something many teachers do on a routine basis. If you were asked to do this, how would you go about tackling this task?

SpeedKingz/Shutterstock.com

Photo 2-1
The GAME plan allows you to explore and learn about new and emerging technologies as they become available for teaching and learning.

Set Goals

The first step in the GAME plan is to *set goals*. At this stage, you'll identify what you need to know as specifically as possible. You wonder whether coding is something you should think about for your classroom. You'll also recall what you know about coding already, noting it's a popular topic being talked about in the news by politicians and business leaders and through educational promotions like Hour of Code and Code.org. You know how important coding can be for certain professions but probably have a few questions related to your specific classroom needs, especially for younger students: How have teachers used different coding programs in their classrooms? What are the coding resources others have used? Can programming a robot really enhance student learning? What coding activities are appropriate for elementary students? These