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Transforming Learning with New Technologies

FOURTH EDITION

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Fourth Edition

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To the students we are learning from and
the students they are learning from,
the teachers of today and tomorrow.

About the Authors

Robert W. Maloy is a senior lecturer in the Department of Teacher Education and Curriculum Studies in the College of Education at the University of Massachusetts Amherst, where he coordinates the history and political science teacher education programs. He also co-directs the TEAMS Tutoring Project, a community engagement/service learning initiative in which university students provide academic tutoring to culturally and linguistically diverse students in public schools throughout the Connecticut River Valley region of western Massachusetts. His research focuses on technology and educational change, teacher education, democratic teaching, and student learning. He is coauthor of eight other books: *Kids Have All the Write Stuff: Revised and Updated for a Digital Age; Wiki Works: Teaching Web Research and Digital Literacy in History and Humanities Classrooms; We, the Students and Teachers: Teaching Democratically in the History and Social Studies Classroom; Ways of Writing with Young Kids: Teaching Creativity and Conventions Unconventionally; Kids Have All the Write Stuff: Inspiring Your Child to Put Pencil to Paper; The Essential Career Guide to Becoming a Middle and High School Teacher; Schools for an Information Age;* and *Partnerships for Improving Schools.* Robert has received a University of Massachusetts Amherst Distinguished Teaching Award (2010), the University of Massachusetts President's Award for Public Service (2010), a School of Education Outstanding Teacher Award (2004), a University Distinguished Academic Outreach Award (2004), and the Chancellor's Certificate of Appreciation for Outstanding Community Service (1998 and 1993).

Ruth-Ellen Verock is a senior lecturer in the Department of Teacher Education and Curriculum Studies in the College of Education at the University of Massachusetts Amherst. She coordinates *Bridges to the Future*, a one-year intensive master's degree and secondary teacher license program serving school systems in western Massachusetts. Prior to joining the university, Ruth was an elementary school classroom and reading teacher in Virginia and Massachusetts. Her academic research focuses on new teacher education, technology in teaching, and community service learning in K–12 schools. She is coauthor with Robert W. Maloy and Sharon A. Edwards of *Ways of Writing with Young Kids: Teaching Creativity and Conventions Unconventionally.* She received the School of Education's Outstanding Teacher Award in 2007. She served as coordinator of the 2003 University of Massachusetts/WGBY National Teacher Training Institute (NTTI) and was an educational researcher for the 1999–2000 Harvard University Evidence Project.

Sharon A. Edwards is a clinical faculty member in the Department of Teacher Education and Curriculum Studies in the College of Education at the University of Massachusetts Amherst. Retired from public school teaching, she taught primary grades for 32 years at the Mark's Meadow Demonstration Laboratory School, a public laboratory school in Amherst, Massachusetts. As a clinical faculty member, she mentors undergraduate students and graduate student interns in the early childhood teacher education, constructivist teacher education, and secondary teacher education programs. Her college teaching and workshop presentations focus on children's writing, reading, and math learning; curriculum development; instructional methods; and diversity and equity in education. She also co-directs the university's TEAMS Tutoring Project. In 1989, Sharon was the inaugural recipient of the national Good Neighbor Award for Innovation and Excellence in Education given by the State Farm Insurance Companies and the National Council of Teachers of English for her work with young children's writing. She received her Doctor of Education degree from the University of Massachusetts Amherst in 1996. She is coauthor with Robert W. Maloy of two other books: *Ways of Writing with Young Kids* and *Kids Have All the Write Stuff.*

Torrey Trust, Ph.D., is an associate professor of Learning Technology in the Department of Teacher Education and Curriculum Studies in the College of Education at the University of Massachusetts Amherst, where she is the co-coordinator of the Learning, Media and Technology master's degree program. Her research and teaching focus on how technology can support teachers in designing contexts that enhance student learning. Dr. Trust is the past president of the Teacher Education Network for the International Society for Technology in Education (ISTE) (2016–2018). Her research, teaching, and service to the field of educational technology have received noticeable recognition, including the 2016 ISTE Online Learning Network Award, 2017 Outstanding Research Paper Award for the *Journal of Digital Learning in Teacher Education*, 2017 American Educational Research Association (AERA) Instructional Technology Special Interest Group Best Paper Award, 2017 ISTE Emerging Leader Award, 2017 Association for Educational Communication & Technology Division of Distance Learning Crystal Award (second place), 2018 Making IT Happen (ISTE) Award, and 2019 AERA Technology as an Agent of Change for Teaching & Learning (Special Interest Group) Early Career Scholar Award.

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Preface

Welcome to the fourth edition of *Transforming Learning with New Technologies*. We have written this book to demonstrate the limitless ways teachers and students can use desktops, laptops, smartphones, tablets, apps, interactive websites, coding, makerspaces, 3-D modeling and printing, serious learning games, assistive technologies, performance assessments, and many more new and emerging technologies to create highly interactive, inquiry-based teaching and learning experiences in K–12 schools.

Our goal is to help you transform classrooms into technology-infused places of learning where teachers and students are active educational partners, working together to use and understand technology. Focusing on day-to-day realities of elementary and secondary schools, each chapter addresses the needs of future educators. We provide thoughtful perspectives, instructional examples, descriptions of technology tools and apps, and technology-integrated lesson plans from across the curriculum and for all grade levels as starting points for new teachers to use in developing technology-based learning for students.

As technology transforms every aspect of our lives and our society—from science, medicine, and business to family, entertainment, and education—this fourth edition seeks to support future teachers as they re-envision the roles of technology in schools. Our highly technological, knowledge-based society demands that teachers and students possess new knowledge and expanded talents to be successful in careers and life—what the Partnership for 21st Century Skills calls the "3 Rs and the 4 Cs" of our digital age.

The 3 Rs refer to the academic curriculum content that is taught across the grade levels where teachers add problem solving and inquiry learning to the time-honored skills of reading, writing, and number operations in the subject fields of reading/language arts, mathematics, the sciences, world languages, the arts, economics, geography, history, and government/civics. The 4 Cs are the skills and talents of critical thinking, communication, collaboration, and creativity that every teacher and student must have to understand and succeed in the world of today and tomorrow.

Teaching and learning with the 3 Rs and the 4 Cs mean teachers prepare, deliver, and assess lessons differently while students participate by thinking critically and creatively about all learning they do and what technologies they use, transforming themselves from passive consumers of information *from* technology to active creators of knowledge and understanding *with* technology.

Each of us—young and old, novice or experienced technology user—is living through social, economic, and technological revolutions that are remaking every aspect of our lives, including education. Learning about technology is the essential step in using it successfully both as a teacher and as a learner. Digital technologies directed by the creative ideas that you bring to the art and craft of teaching will continue changing K–12 schools throughout your career. You are only just beginning. In that spirit, we invite you to join us in exploring how *new technologies* create *new opportunities* to *transform teaching and learning* in schools.

New to This Edition

This edition has been substantially revised and updated to incorporate the latest developments in educational technology and digital learning. In it, you will find:

- **Chapters aligned to the newest International Society for Technology in Education (ISTE) Standards**—the first five chapters are aligned to the 2017 ISTE Standards for Educators; the final seven chapters are aligned to the 2016 ISTE Standards for Students. The ISTE Standards for Educators and Students (formerly called NETS for Teachers and NETS for Students) describe and illustrate ways for teachers and students to use technology to achieve learning goals and outcomes. Each chapter supports ISTE's broad vision of technology-infused learning by providing examples, models, and strategies for using interactive technologies to create new patterns of teaching and learning at every grade level.
- **Material on the latest highly interactive technologies and strategies for teaching and learning**—tablets and apps, flipped classrooms, computational thinking, learning to code, 3-D printing, microblogging, online learning, virtual schools, open educational resources, digital citizenship, performance assessments, and using technology with culturally and linguistically diverse learners. An emphasis on highly interactive tools and strategies reflects the changing nature of educational technology from singular devices used by individuals to collaborative tools used by groups and communities.
- **Online Application Exercises in each chapter** focus on having readers utilize digital technologies and apply them directly to their development as educators. Readers are invited to explore technology tools in more depth to experience how they might use these tools in their future classrooms.
- **Technology Transformation Plans** at the end of chapters have been renamed and refocused as "Technology Transformation Learning Plans" to emphasize the educational outcomes for students that result from the ways teachers integrate technology into classroom lessons and learning activities.
- **Designing Instruction with Technology—**the focus of Chapter 4 has been re-envisioned and re-organized to more directly address instructional design with technology. The chapter includes material on different

types of educational websites and apps, as well as a step-by-step presentation of the instructional design process in action using two science lessons—one for elementary age learners, the other for middle and high school students.

- **Teachers as Technology Leaders**—a chapter on teacher leadership has added material on the SAMR Model of Technology Integration, one-to-one computing and BYOD/T programs, and the role of teachers in addressing digital inequalities facing low-income and culturally and linguistically diverse youngsters. There are also strategies for how new teachers can most effectively manage their online presence and digital reputation on social media.
- **Digital Literacies**—Expanded coverage of digital literacy includes new material on open educational resources (OERs) and public domain materials, as well as strategies for teaching students how to do online research, evaluate the quality of web materials, and recognize and reject fake and false news.
- **Problem Solving and Inquiry Learning**—An entirely revised chapter focuses on using coding, robotics, makerspaces, and 3-D printing with students in schools. The chapter features new material on serious educational games and game-based learning along with a new Technology Transformation Learning Plan: *Recreating Pre-Contact Native American Houses with a Makerspace and 3-D Printing*.
- **Technology for Diverse Learners**—A substantially reorganized chapter emphasizes using technology to support learning for culturally and linguistically diverse students as well as youngsters with special educational needs. There is material on culturally responsive teaching, teaching students who are learning English as a new language, creating digitally accessible assignments for students, and using technology to support a writing process fit for young writers.
- **MyLab Education**
  One of the most visible changes in the fourth edition, also one of the most significant, is the expansion of the digital learning and assessment resources embedded in the eText and the inclusion of MyLab Education in the text. MyLab Education is an online homework and assessment program designed to work with the text to engage learners and to improve learning. Within its structured environment, learners see key concepts demonstrated through real classroom video footage, practice what they learn, test their understanding, and receive feedback to guide their learning and to ensure their mastery of key learning outcomes. Designed to bring learners more directly into the world of K–12 classrooms and to help them see the real and powerful impact of educational technology concepts covered in this book, the online resources in MyLab Education with the Enhanced eText include:
  - **Video Examples.** Embedded videos provide illustrations of educational technology principles or concepts in action. These video examples most often show students and teachers working in classrooms. Sometimes they show students or teachers describing their thinking or experiences.
  - **Self-Checks.** In each chapter, self-check quizzes help assess how well learners have mastered the content. The self-checks are made up of self-grading multiple-choice items that not only provide feedback on whether questions are answered correctly or incorrectly, but also provide rationales for both correct and incorrect answers.
  - **Application Exercises.** Every chapter in the fourth edition includes three interactive Application Exercises called "Application Exercises offer hands-on, technology-based opportunities to explore tools and resources that technology-using educators will want to know about and be able to use with K-12 students. Tech Tool exercises are ways to "test-drive" digital tools, experiencing first-hand how they can function instructionally in school settings. Building Your PLN exercises feature digital technologies that future teachers can add to their professional resume of skills and understandings. Growing and Leading with Technology exercises invite readers to develop their own "what would you do" responses to actual classroom scenarios. Application Exercises have thought questions to answer, after which readers can view our author feedback for each question.

1. Becoming a 21st Century Teacher
   - Application Exercise 1.1: Tech Tool: *Transforming Technology Tools for Tablets, Smartphones and Laptops*
   - Application Exercise 1.2: Building Your PLN: *Selecting Professional Pull and Push Resources*
   - Application Exercise 1.3: Growing and Leading with Technology: *Marco's "PLN Building" Activity*
2. Understanding Educational Technology Issues and Trends
   - Application Exercise 2.1: Building Your PLN: *Examining Apps for Safety and Privacy*
   - Application Exercise 2.2: Tech Tool: *Writing a Review of an Educational App*
   - Application Exercise 2.3: Growing and Leading with Technology—*Cherelle's "Using Technology in the Classroom" Activity*
3. Transforming Learning with Unique, Powerful Technologies
   - Application Exercise 3.1: Building Your PLN: *Web Resources and Apps for Critical Thinking and Problem Solving*
   - Application Exercise 3.2: Building Your PLN: *Web Resources and Apps for Digital Literacy Learning*
   - Application Exercise 3.3: Building Your PLN: *Web Resources and Apps for Digital Communication and Collaboration*
   - Application Exercise 3.4: Building Your PLN: *Web Resources and Apps for Creativity*
   - Application Exercise 3.5: Building Your PLN: *Web Resources and Apps for Digital Citizenship*

4. Designing Instruction with Technology
   - Application Exercise 4.1: Tech Tool: *Exploring Educational Websites and Apps*
   - Application Exercise 4.2: Building Your PLN: *Designing a Classroom Learning Activity with Technology*
   - Application Exercise 4.3: Growing and Leading with Technology—*Tony's "Planets in the Solar System" Learning Activity*
5. Applying Technology as Teacher Leaders and Innovators
   - Application Exercise 5.1: Tech Tool: *Using Technology as Mindtools*
   - Application Exercise 5.2: Building Your PLN: *Managing Your Online Presence as A Teacher*
   - Application Exercise 5.3: Growing and Leading with Technology—*Kate's "Becoming a Technology Leader in Her First Teaching Job"*
6. Teaching Information Literacy and Digital Citizenship
   - Application Exercise 6.1: Tech Tool: *Exploring the Interactive Features of an OER e-Textbook*
   - Application Exercise 6.2: Building Your PLN: *The Multiple Dimensions of Digital Citizenship*
   - Application Exercise 6.3: Growing and Leading with Technology—*Erich's "Researching the First Thanksgiving" Learning Activity*
7. Engaging in Virtual Learning with Online Resources
   - Application Exercise 7.1: Tech Tool: *Assembling a Social Bookmarking Collection*
   - Application Exercise 7.2: Building Your PLN: *Curating Multimedia Standards-based Content*
   - Application Exercise 7.3: Growing and Leading with Technology—*Irene and Stacy's "Thinking Globally, Acting Locally" Learning Activity*
8. Solving Problems and Designing Solutions through Coding, Makerspaces and Serious Gaming
   - Application Exercise 8.1: Building Your PLN: *Evaluating Apps for Learning to Code*
   - Application Exercise 8.2: Tech Tool: *Reviewing a Digital Game for Learning*
   - Application Exercise 8.3: Growing and Leading with Technology: *Sharon's "Inventions and Technologies" Learning Activity*
9. Communicating and Collaborating with Social Technologies
   - Application Exercise 9.1: Tech Tool: *Doing Twitter-based Learning Activities with Students*
   - Application Exercise 9.2: Building Your PLN: *Locating Multimodal Resources for a Collaborative Project-Based Wiki or Google Site*
   - Application Exercise 9.3: Growing and Leading with Technology—*Brook's "Who Came Down That Road?" Learning Activity*
10. Expressing Creativity with Multimedia Technologies
    - Application Exercise 10.1: Tech Tool: *Selecting a Podcast Learning Source for Students*
    - Application Exercise 10.2: Building Your PLN: *Creating a Teacher Channel for Video Resources*
    - Application Exercise 10.3: Growing and Leading with Technology—*Drew's "Physics of Projectile Motion" Learning Activity*
11. Differentiating Instruction with Technology
    - Application Exercise 11.1: Building Your PLN: *Differentiating Instruction through Low Tech/Mid Tech/High Tech Accommodations*
    - Application Exercise 11.2: Tech Tool: *Interactive Vocabulary Learning Tools in a Writing Process Fit for Young Writers*
    - Application Exercise 11.3: Growing and Leading with Technology: *Shannon's "This I Believe Essay" Learning Activity*
12. Empowering Learners through Performance Assessments and Reflection
    - Application Exercise 12.1: Building Your PLN: *Developing Student Feedback Survey Questions*
    - Application Exercise 12.2: Tech Tool: *Reviewing an Online Quiz Game*
    - Application Exercise 12.3: Growing and Leading with Technology—*Mayalyn's "Math Review" Learning Activity*

Author-Created Companion Site

To provide ongoing updates and resources for the 4th edition, we have developed a companion Google site, also called transforming learning with new technologies. It replaces transformingtech, our companion wiki for the 3rd edition. At the new site you will find material related to key topics in each chapter. As new research, materials, and resources become available, our plan is to post them on the site so everyone can find up-to-date news and information about technology, schools, and learning. THE SITE IS FREE ONLINE AT https://sites.google.com/view/transformlearningwithtech

Chapter Organization and Updates

Each chapter is organized around specific learning goals designed to provide teachers and students with information to create successful, technology-infused learning environments in K–12 schools and classrooms.

- Chapter 1 introduces the changing context of education in an increasingly multicultural, multilingual society, along with what it means to be a 21st century teacher who uses technology for teaching and learning. There is material updating Bloom's taxonomy with technology, an introduction to the newest ISTE Standards for Educators and Students, and ideas for how to use this book to begin building a PLN (professional learning network) as a new teacher.
- Chapter 2 identifies the latest issues, developments, and trends in the field of educational technology. There is material on using technology to engage students as well as the impacts of digital inequalities on student achievement gaps. Overcoming differences between student-initiated and teacher-chosen technology use is

a key to addressing a persistent digital disconnect that many students feel at school.

- Chapter 3 discusses how technology can generate unique, powerful, and transforming learning (UPT) as defined by the ISTE Standards for Students and 21st Century Student Outcomes. There are technology-based learning activities, web resources and apps for critical thinking and problem solving, digital literacy, communication and collaboration, creativity, and digital citizenship.
- Chapter 4 reviews learning theories and design processes for incorporating technology into lesson planning, classroom teaching, and student assessment, including constructivist and student-centered approaches to the essential elements of instructional design. Two science lessons, one each for elementary school and high school students, provide a step-by-step overview of the instructional design process in action.
- Chapter 5 discusses the dynamics of integrating technology into teaching while creating educational change in schools. There is a focus on using technology to address digital inequalities and student participation gaps in school classrooms, including one-to-one computing, flipped learning, and interactive educational materials. There are also strategies for college students to utilize to become technology-leading educators.
- Chapter 6 examines the multiple dimensions of information literacy and digital citizenship. Beginning with the importance of digital literacy for teachers and students, there is material on identifying fake and false news, using search engines effectively, critically assessing online materials, and utilizing open educational resources (OERs) and public domain materials. There are also strategies for teaching students how to act responsibly as digital citizens.
- Chapter 7 focuses on using online digital content for teaching and learning while also examining the growth and development of blended learning and virtual schools. Technologies and strategies for curating information include an overview of Google's collection of tools for teachers. There is also material on the strengths and drawbacks of online learning and the importance of using exploratory learning websites and apps to engage students in academic learning.
- Chapter 8 shows ways to develop students' inquiry-learning and problem-solving skills using technology. Teaching coding and robotics engages students in problem-based learning. Serious learning games, online simulations, and virtual reality applications offer students open-ended ways to practice problem solving by thinking critically. Makerspaces and 3-D modeling and printing place students in the roles of inventors, creators, and engineers of creative learning experiences.
- Chapter 9 explains how teachers and students can use digital communication technologies to enhance collaboration, share information, and promote new learning. There are strategies for utilizing e-mail, text messaging, Twitter, and online discussions as a teacher. Blogs, wikis, and Google sites are discussed as technologies for engaging students and implementing collaborative project-based learning activities.
- Chapter 10 explores multimedia technologies and their roles in promoting multimodal learning and student creativity. There are strategies for utilizing e-books and e-readers, educational podcasts, and next-generation presentation tools. There are also ideas and tools for incorporating video in the classroom and supporting students as they engage in photo taking, digital storytelling, and movie-making.
- Chapter 11 explains how technology supports differentiated instruction and universal design for learning by emphasizing educational success for all students. There are tools and strategies for engaging culturally and linguistically diverse learners; an overview of assistive technologies that support students with special educational challenges; and tools for teaching writing within a writing process fit for young writers.
- Chapter 12 demonstrates how teachers and students can become active participants in evaluating and assessing their own growth as learners using technology. The role of assessment in K–12 education is explored along with different types of technology-based, student-centered assessments, including student performance rubrics, democratic classrooms, student feedback surveys, and student participation tools. Digital portfolios for students and teachers are also highlighted as ways for individuals to self-assess personal learning.

In-Chapter Features

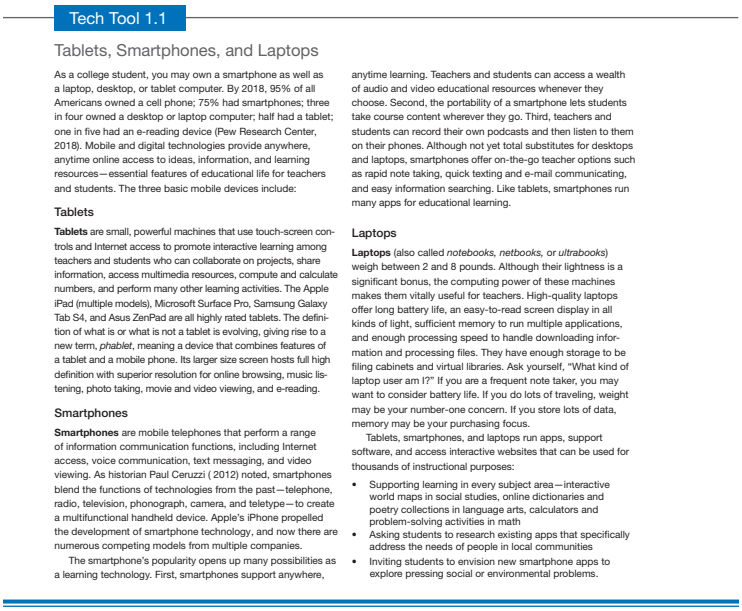
CHAPTER-OPENING PEDAGOGY Each chapter begins with learning outcomes connected to each major heading in the chapter. This establishes the framework for what students should know and be able to do when they complete the chapter. Following the learning outcomes is a graphic organizer outlining the chapter's learning goals; ISTE standards connections; and apps and tools that appear in the chapter. Learning goals offer a guide for students' reading and brief vignettes of real-life situations in schools that introduce the chapter's main theme.

END-OF-CHAPTER ACTIVITIES The following materials provide a thorough review of the chapter and extend student thinking beyond the chapter focus:

- **Chapter Summaries** of the major ideas correspond to the learning outcomes found at the beginning of the chapter.
- **Key Terms** list the important terminology found in the chapter. Terms are found in bold within the chapter text and are defined in the glossary at the end of the book.
- **For Reflection and Discussion** offers end-of-the-chapter questions and exercises for the purpose of individual reflection, group dialogue, and personal writing to reinforce chapter content and its learning goals.

- **Chapter Learning Outcomes** have been consolidated to reflect the evolving emphasis on social media, apps, online digital content, and new interactive tools for teaching and learning. Each learning outcome corresponds to a section within the chapter, arranged from the conceptual to the practical so readers receive an introduction to concepts and learning goals and are then shown ways to implement them in school classrooms.
- **In Practice** is a boxed feature in every chapter that offers classroom-based examples of teachers and students using new technologies for classroom learning. Every In Practice showcases one of the key ideas or technologies being discussed in the chapter by focusing on its practical applications in K–12 schools.

TECH TOOLS Tech Tools in each chapter profile high-quality, easy-to-use, and easy-to-obtain digital tools, apps, and web-based resources that can enhance your work as a teacher, both instructionally and professionally. We describe each tool, how it can be used educationally, and why it is important for teaching and learning. In the eText edition, each Tech Tool includes an interactive, learner-centered Application Exercise designed to help readers of the book explore tools and apps in greater depth. All Tech Tool resources have been class-tested by the authors and students.



Tech Tool 1.1

Tablets, Smartphones, and Laptops

As a college student, you may own a smartphone as well as a laptop, desktop, or tablet computer. By 2018, 95% of all Americans owned a cell phone; 75% had smartphones; three in four owned a desktop or laptop computer; half had a tablet; one in five had an e-reading device (Pew Research Center, 2018). Mobile and digital technologies provide anywhere, anytime online access to ideas, information, and learning resources—essential features of educational life for teachers and students. The three basic mobile devices include:

Tablets

Tablets are small, powerful machines that use touch-screen controls and Internet access to promote interactive learning among teachers and students who can collaborate on projects, share information, access multimedia resources, compute and calculate numbers, and perform many other learning activities. The Apple iPad (multiple models), Microsoft Surface Pro, Samsung Galaxy Tab S4, and Asus ZenPad are all highly rated tablets. The definition of what is or what is not a tablet is evolving, giving rise to a new term, *phablet*, meaning a device that combines features of a tablet and a mobile phone. Its larger size screen hosts full high definition with superior resolution for online browsing, music listening, photo taking, movie and video viewing, and e-reading.

Smartphones

Smartphones are mobile telephones that perform a range of information communication functions, including Internet access, voice communication, text messaging, and video viewing. As historian Paul Ceruzzi (2012) noted, smartphones blend the functions of technologies from the past—telephone, radio, television, phonograph, camera, and teletype—to create a multifunctional handheld device. Apple's iPhone propelled the development of smartphone technology, and now there are numerous competing models from multiple companies.

The smartphone's popularity opens up many possibilities as a learning technology. First, smartphones support anywhere, anytime learning. Teachers and students can access a wealth of audio and video educational resources whenever they choose. Second, the portability of a smartphone lets students take course content wherever they go. Third, teachers and students can record their own podcasts and then listen to them on their phones. Although not yet total substitutes for desktops and laptops, smartphones offer on-the-go teacher options such as rapid note taking, quick texting and e-mail communicating, and easy information searching. Like tablets, smartphones run many apps for educational learning.

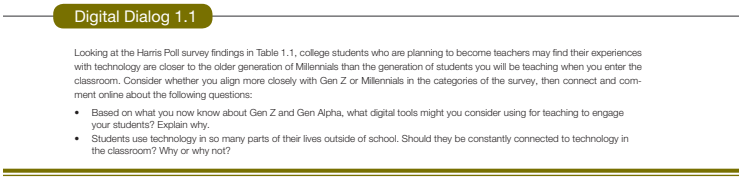
Laptops

Laptops (also called *notebooks*, *netbooks*, or *ultrabooks*) weigh between 2 and 8 pounds. Although their lightness is a significant bonus, the computing power of these machines makes them vitally useful for teachers. High-quality laptops offer long battery life, an easy-to-read screen display in all kinds of light, sufficient memory to run multiple applications, and enough processing speed to handle downloading information and processing files. They have enough storage to be filing cabinets and virtual libraries. Ask yourself, "What kind of laptop user am I?" If you are a frequent note taker, you may want to consider battery life. If you do lots of traveling, weight may be your number-one concern. If you store lots of data, memory may be your purchasing focus.

Tablets, smartphones, and laptops run apps, support software, and access interactive websites that can be used for thousands of instructional purposes:

- Supporting learning in every subject area—interactive world maps in social studies, online dictionaries and poetry collections in language arts, calculators and problem-solving activities in math
- Asking students to research existing apps that specifically address the needs of people in local communities
- Inviting students to envision new smartphone apps to explore pressing social or environmental problems.

DIGITAL DIALOG A boxed feature in each chapter invites readers to use social media and in-class conversations to explore issues raised throughout the book. Brief questions focus attention on current thinking and future plans. From their own and other students' written reflections, readers learn ways to use new technologies for teaching and learning.

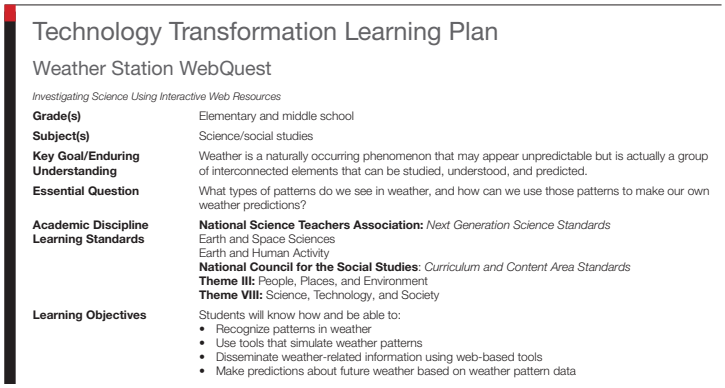


Digital Dialog 1.1

Looking at the Harris Poll survey findings in Table 1.1, college students who are planning to become teachers may find their experiences with technology are closer to the older generation of Millennials than the generation of students you will be teaching when you enter the classroom. Consider whether you align more closely with Gen Z or Millennials in the categories of the survey, then connect and comment online about the following questions:

- Based on what you now know about Gen Z and Gen Alpha, what digital tools might you consider using for teaching to engage your students? Explain why.
- Students use technology in so many parts of their lives outside of school. Should they be constantly connected to technology in the classroom? Why or why not?

TECHNOLOGY TRANSFORMATION LEARNING PLANS Found at the end of Chapters 6–12, Technology Transformation Learning Plans show teachers how to infuse technology in a substantive and meaningful way using a standard lesson plan template with objectives, methods, assessment strategies, national subject area curriculum standards, and the ISTE Standards for Students. Relating directly to the learning goals and new technologies featured in the chapter, each lesson plan offers "before-and-after" insights via a table that includes one column, "Minimal Technology" (the "before" mode), describing how teachers might conduct a lesson without a significant role for technology, and a second column, "Infusion of Technology" (the "after" mode), illustrating how technologies can fundamentally enhance and transform learning for students and teachers. The Technology Transformation Learning Plans are correlated to the ISTE Standards for Students.



Technology Transformation Learning Plan

Weather Station WebQuest

Investigating Science Using Interactive Web Resources

Grade(s)	Elementary and middle school
Subject(s)	Science/social studies
Key Goal/Enduring Understanding	Weather is a naturally occurring phenomenon that may appear unpredictable but is actually a group of interconnected elements that can be studied, understood, and predicted.
Essential Question	What types of patterns do we see in weather, and how can we use those patterns to make our own weather predictions?
Academic Discipline Learning Standards	**National Science Teachers Association:** *Next Generation Science Standards* Earth and Space Sciences Earth and Human Activity **National Council for the Social Studies**: *Curriculum and Content Area Standards* **Theme III:** People, Places, and Environment **Theme VIII:** Science, Technology, and Society
Learning Objectives	Students will know how and be able to: • Recognize patterns in weather • Use tools that simulate weather patterns • Disseminate weather-related information using web-based tools • Make predictions about future weather based on weather pattern data

PROFESSIONAL LEARNING NETWORK (PLN) An expanded inside-the-chapter Application Exercise provides readers with technology exploration activities to complete as they read the book. These hands-on activities are designed to help readers develop a portfolio of knowledge and skills to use when entering the teaching job market and throughout their career. PLNs are a popular concept for new teachers, for as technology educator Torrey Trust (2012, p. 133) noted: "PLNs connect teachers to other individuals worldwide who can offer support, advice, feedback, and collaboration opportunities." PLNs also allow teachers to collect information from various websites so they can stay up-to-date on the latest teaching techniques, pedagogies, and changes in the field of education.

Support Materials for Instructors

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

Instructor's Resource Manual and Test Bank

The Instructor's Resource Manual and Test Bank includes suggestions for learning activities, additional Experiencing Firsthand exercises, supplementary lectures, case study analyses, discussion topics, group activities, and a robust collection of test items. Some items (lower-level questions) simply ask students to identify or explain concepts and principles they have learned. But many others (higher-level questions) ask students to apply those same concepts and principles to specific classroom situations—that is, to actual student behaviors and teaching strategies.

PowerPoint Slides

The PowerPoint slides include key concept summarizations, diagrams, and other graphic aids to enhance learning. They are designed to help students understand, organize, and remember core concepts and theories.

TestGen

TestGen is a powerful test generator that instructors install on a computer and use in conjunction with the TestGen testbank file for the text. You install TestGen on your personal computer (Windows or Macintosh) and create your own tests for classroom testing and for other specialized delivery options, such as over a local area network or on the web. A test bank, which is also called a Test Item File (TIF), typically contains a large set of test items, organized by chapter and ready for use in creating a test based on the associated textbook material. Assessments may be created for both print and online testing.

The tests can be downloaded in the following formats:

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

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Chapter 1

Becoming a 21st Century Teacher

SOURCE: Hquality/Shutterstock

Chapter Overview

Chapter 1 introduces skills, talents, and technologies 21st century teachers will be using to create interactive, engaging learning experiences for themselves and students. We open with an overview of technology's centrality in the lives of students and families and its integration in the work of teachers. The current International Society for Technology in Education (ISTE) Standards for Students and Educators as well as Bloom's taxonomy of educational objectives, the technological pedagogical content knowledge (TPACK), and 21st century skills are introduced to frame how new teachers think about technology's role in teaching and learning. In a final section, we introduce a professional learning network (PLN) as a framework for how new teachers can continually expand and document what they know and can do as technology-leading and learning educators. The chapter addresses the "Leader" domain of the ISTE Standard for Educators, which urges teachers to continually look for and learn about new ways for technology to improve successful learning for students.

Learning Outcomes

After reading this chapter, you will be able to:

1.1 Summarize the changing diversity of American education and the roles of technology in the lives of students and families.

1.2 Discuss ways teachers utilize digital technologies in their work as educators.

1.3 Analyze how 21st century technologies can be used to create highly interactive, inquiry-based learning environments.

1.4 Organize a professional learning network (PLN) as a technology-using educator.

Chapter Learning Goal

Understand students, schools, and technologies as a 21st century technology-using teacher.

Featured Technologies

Computers
Laptops
Tablets
Smartphones
Apps
Social media
Professional learning network (PLN)
Web 2.0/3.0

Two New Teachers and Their Technologies

Hilary remembers always wanting to be a teacher. From grade school on, she imagined herself in a classroom teaching her favorite subjects. She is from a family of teachers—her father taught and coached at a local high school, and her older sister is a speech therapist in a nearby elementary school. Going to college was always in her plans, and when she arrived at her four-year school, she majored in history and teacher education.

Becoming a teacher was the furthest thing from Anthony's mind when he graduated from high school and enrolled in a local community college as a part-time student. As he gradually earned the credits to transfer to a four-year school and major in biology, the idea of teaching science to younger students began to appeal to him as a career choice.

As diverse as these two appear to be, Hilary and Anthony are constant technology users. Neither goes anywhere without a smartphone. Both enjoy watching YouTube videos and downloading music on their handheld devices. While each has an e-mail account, texting, Instagram, and Snapchat are their preferred modes of communicating with friends. Playing video games, shopping online, watching television, doing mobile banking, and streaming movies are daily parts of their media lives.

Seeing technology influencing their own learning, Hilary and Anthony sought ways to use digital tools for teaching students. Hilary helped build and expand a wiki of multimodal web resources to assist history teachers in developing technology-infused learning plans. Anthony began bookmarking online simulations and games for students to play while making science-in-the-real-world videos on his smartphone and editing them as part of inquiry-based lessons. For both Hilary and Anthony, technology for teaching became a central part of becoming an educator.

Although they took different routes to teaching, Hilary and Anthony consistently learned about technology through their use of it in their own lives. When they were in high school and college, technology meant texting, **social media**, and entertainment through **apps**, games, streaming videos, digital music, and online blogs and news sites. As teachers entering classrooms for the first time, however, they were not experienced with how to use the power of technology to transform learning. They had to learn new digital tools and discover unforeseen possibilities of technology-based learning to become 21st century teachers.

Our goal for you is to become a confident, thoughtful user of educational technologies in courses, classrooms, and professional settings while you develop your knowledge, skills, and talents as a technology-leading and learning teacher. In this opening chapter, we focus attention on four questions central to your growth and development as a teacher in the digital age:

1. What are the characteristics of today's rapidly changing, increasingly diverse schools?
2. What technologies are integral to your work as a 21st century teacher?
3. How might the ISTE Standards for Students and Educators, technological pedagogical content knowledge (TPACK), and 21st century skills shape your teaching practice?
4. How can you begin developing a professional learning network (PLN) as a teacher?

Students of all ages use technology for learning and socializing.

SOURCE: Rob/Fotolia (top);
SOURCE: Pressmaster/Fotolia (bottom)

Teaching and Students Today

1.1 Summarize the changing diversity of American education and the roles of technology in the lives of students and families.

Teaching is a career that matters to everyone—students, families, employers, and society. Filled with endless complexities, questions, and rewards, the profession is clearly committed to continuous professional development and academic learning. As a teacher, you are expected to:

- Convey essential academic material to students in ways they will understand, remember, and apply
- Educate, inspire, engage, and create success for every student, each of whom has a unique background of culture, social class, family income, gender, language, and individual exceptionalities
- Manage inside-the-classroom dynamics of interpersonal interactions, behavior, and community and daily routines to sustain academic learning in the lives of students, families, and communities.

As Philip Jackson (1968) chronicled five decades ago, a teacher handles some 200 separate interpersonal interactions every hour, 6 hours a day, for 180 school days each year—a huge endeavor. Faced with these multiple and often competing goals, beginning educators draw on years of personal experience as students to balance it all. They tend to teach as they have been taught, utilizing whole-group instruction with desks arranged in rows while students take notes, complete worksheets, write papers, and receive grades based on multiple-choice test scores. As a result of these established

instructional routines, many classrooms feature large amounts of teacher talk while students passively listen to what teachers say.

Traditional practices, from before and throughout the 20th century, fail to engage large numbers of students, including students who are too far behind or ahead academically; students who prefer to learn by moving, drawing, or singing; and learners who are deeply connected with technology outside of school, but have to power down their devices in school. Todd Rose, in his TED talk "The Myth of Average" (2013), pointed out that "Even though we have one of the most diverse countries in the history of the world, and even though it's the 21st century, we still design our learning environments, like textbooks, for the average student." As a result, Rose concludes, "We've created learning environments that, because they are designed on average, cannot possibly do what we expected them to do, which is to nurture individual potential . . . Because every single student has a jagged learning profile, it means that the average hurts everyone, even our best and brightest."

Creating interactive and inspiring learning experiences for students is today's greatest educational challenge, made all the more complex in classrooms with students from many backgrounds, cultures, and languages who possess different levels of interest in the curriculum and have divergent learning preferences. To teach effectively, educators at every grade level must know how to utilize multiple technologies to promote and sustain student learning. Technology enables new ways to engage students by:

- Differentiating instruction to offer students diverse learning experiences
- Energizing learning with interactive tools
- Creating collaborative learning situations
- Enabling access to academic information from multiple sources
- Visiting places and observing processes that cannot be seen otherwise.

A Rapidly Changing and Diversifying Society

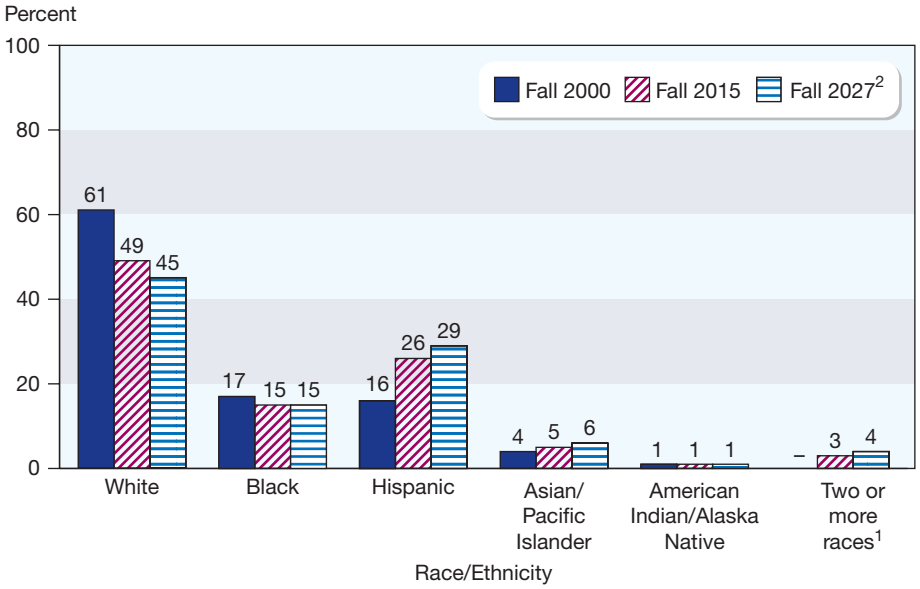
As you prepare to teach, you do so within the context of a rapidly changing and diversifying society in which:

- ***The K–12 school population is becoming more culturally and linguistically diverse.*** Demographer William H. Frey (2018a, 2018b) refers to these changes as a "**diversity explosion**." Hispanic, African American, Asian/Pacific Islander, and Native American students now make up more than 50% of the nation's K–12 student population, and the National Center for Education Statistics (2019) is forecasting that the percentage of non-White students in the schools will continue to increase through at least the year 2027 (see Figure 1.1).

  Cultural diversity is accompanied by linguistic diversity—the U.S. Census Bureau (2015) has reported that there are now more than 350 different languages spoken in U.S. homes. Spanish is the second-most spoken language besides English, with more than 40 million speakers, but Chinese (including Mandarin and Cantonese), Tagalog (including Filipino), Vietnamese, Arabic, French, and Korean have at least 1 million speakers as well. Nevada, Florida, California, New York, and Texas are the most diverse states. In California, half of the state's students are Hispanic, and nearly half speak a language other than English at home (Ed100.org, 2018). Diversity is also reflected in the learning needs of students. Thirteen percent of the nation's K–12 students receive special education services; more than half of those students have learning disabilities or speech and language impairments (National Center for Education Statistics, 2018a). Diverse classrooms mean that you can expect to teach in schools that will have many languages, family backgrounds, cultural traditions, and forms of gender expression in student populations.
- ***Multiple achievement gaps persist among students in schools.*** **Achievement gaps** are differences in educational outcomes among groups of students. Black, Hispanic, and Native American students, despite some improvements and gains, continue

Figure 1.1 Percentage Distribution of Students Enrolled in Public Elementary and Secondary Schools, by Race/Ethnicity

SOURCE: U.S. Department of Education/National Center for Education Statistics (February 2019).



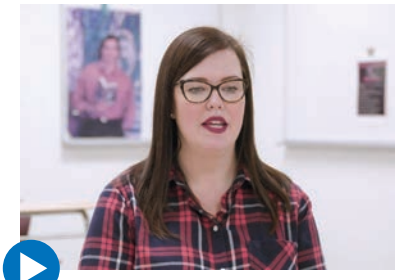
– Not available.
[1] In 2000, data on students of Two or more races were not collected.
[2] Projected.

to perform below White and Asian students in reading and math as measured by the National Assessment of Educational Progress (NAEP), the nation's report card (Hansen, et al., 2018). These youngsters lag behind White and Asian peers in graduating from high school, attending college, and graduating from college. In addition, significant numbers of English language learners, students in special education, and LBGTQ youth remain behind their peers in reading, writing, and math test scores; rates of high school graduation; and choice of math-, science-, and engineering-related careers. There are wide achievement gaps between youngsters from wealthy and poor families (defined as 90th vs. 10th percentiles of income). There are gender-based gaps as well. For instance, girls outperform boys on reading and writing in almost all school districts, while boys from affluent, predominantly White districts outperform girls in math (Reardon, et al., 2018). And even though more girls are taking the AP Computer Science test, girls are less likely than boys to pursue careers in science, technology, engineering, and math (STEM) after high school.

- ***Connectivity gaps remain a pervasive educational issue.*** **Connectivity gaps** are a type of **digital inequality** in which children in low-income, Black, Hispanic, and American Indian/Alaskan Native households are technologically "underconnected" from the digital resources needed for successful life and learning (National Center for Education Statistics, 2018b; Moore, Vitale, & Stawinoga, 2018). Underconnected households either lack Internet access entirely or have broadband speeds too slow to run the latest software programs, and many face the threat of having Internet service cut off at any time for unpaid bills. Connectivity gaps are everywhere. A large majority of youngsters living in rural areas—about one out of every five elementary or secondary school students in the country—report either "terrible," "unpredictable," or just "OK" access to the Internet at home and at school (Croft & Moore, 2019).
- ***Connectivity gaps lead to homework gaps and reduced educational outcomes for students.*** **Homework gaps** happen in many low-income households when students and adults must share a single, often outdated computer (Katz, Gonzalez, & Clark, 2017). Since 80% of eighth-graders use a computer at home for schoolwork, lack of up-to-date technology can result in severe educational disadvantages (National Center for Education Statistics, 2018b). One report documented that 13% of students have difficulty completing homework due to lack of Internet access (Evans, 2018). Another national survey found that fewer than 10% of all school

districts report that every student has access to a non-shared computing device at home. Students without their own device may have difficulty completing their homework (Mayalahn, 2017). By contrast, students from higher-income families are much more likely to have high-speed Internet, use multiple digital devices, and get news and conduct business online. Phone technology also imposes limitations on students' educational experience. While most less affluent youngsters have mobile phones for accessing social media and listening to music, it is not easy to write papers, analyze materials, record data, or view simulations and interactive websites on phones as compared to using the most up-to-date desktop or tablet computers.

- ***Digital inequalities persist in how technology is used in schools as well.*** In theory, youngsters with reduced access to new technologies at home can overcome any educational disadvantages by being able to use and learn with digital tools at school. However, there are persistent technology-based **participation gaps** in classrooms. The same technologies get used differently in different schools, so that even when schools provide access to learning technologies for all students, schools in wealthier communities have students using those technologies in more creative and expansive ways (Reich & Ito, 2017). Students in low-income community schools tend to use technology mainly for basic skills instruction, while students in more affluent districts use technology for more creative, hands-on, exploratory learning such as coding, making games and animations with digital media, and utilizing peer collaboration tools like blogs and wikis.
- ***The role of the teacher is evolving from expert in front of a classroom to facilitator of small learning groups and project-based activities.*** Traditional educational practices (teachers present information while students listen and learn) fail to engage at least half and often most of the students in any given classroom. In surveys and studies, students tell researchers that they want learning in schools to resemble the active, technology-driven learning environments they routinely experience in most other parts of their lives. Multiple educational policy organizations urge teachers to create more interactive, inspiring learning environments that will connect to learners who possess different levels of interest and divergent learning preferences.
- ***Schools are changing in structure and format from traditional brick-and-mortar buildings to many different combinations of in-person and online learning environments.*** Everywhere in the country, you will find widely varying types of schools, including public, private, independent, religious, homeschool, charter, single gender, vocational, agricultural, virtual/online, magnet, language immersion, extended day, year-round, GED preparation, school to college, Montessori, and Reggio Emilia. As a teacher, you are not just getting ready to teach in one type of school for the duration of your career, but preparing to succeed in many different schools with different approaches to teaching and learning.
- ***Beyond the schoolhouse, the nature of jobs and work now places great emphasis on mental rather than physical labor.*** Students today are entering the world of work, where the skills needed are constantly changing, as are the jobs themselves. Employers want employees who have learned how to learn and embrace the idea of "thinking for a living," in Ray Marshall and Marc Tucker's memorable phrase (1993). In every sector of the economy, technology-based professional, managerial, technical, and entrepreneurial careers are emerging all the time, including many that no one could have imagined even a decade ago (e.g., drone operator, 3-D printing specialist, nanotechnology designer, robot operator for surgery). One report on human-machine partnerships forecast that 85% of the jobs for workers in 2030 have not even been invented yet (Institute for the Future for Dell Technologies, 2017). You will be teaching students not only to enter the world of today, but to be prepared for discovering the exciting new opportunities of the future.



MyLab Education

Video Example 1.1

In this video, a teacher discusses the diversity of students in her school. How does the student population of this school compare with the schools you attended as a student?

A Generation of Technology Users

The students in your future classroom will be unlike any generation of students before them. Psychologists Howard Gardner and Katie Davis (2014) have labeled them the "app generation" because they have grown up using computers, the Internet,

smartphones, social media, and interactive digital technologies. The oldest of these students (those born between the mid-1990s and 2010) are members of **Generation Z** (Gen Z); they are also called "post-millennials," "screeners," or the "iGeneration" (Serafino, 2018; Caumont, 2014). The children of Gen Z are a new population cohort known as **Generation Alpha** (Gen Alpha) and includes youngsters born between 2010 and 2025. Knowing about these generations is vitally important for you as a teacher, because the more informed you are about students and technology, the better you will understand their interests, motivations, and goals, as well as the types of educational methodologies needed to successfully teach them in K–12 schools.

From the earliest ages, children from Gen Z and Gen Alpha live media-saturated lives, constantly receiving images and information from televisions, computers, video and picture sharing websites, video games, and smartphones as participants in what sociologists have called a **digital childhood** (Vandewater, et al., 2007). Growing up digital includes the following:

- Almost all infants, toddlers, and preschoolers watch television (nearly every U.S. home has one) while making increasing use of digital tablets, smartphones, and social networks (Donahue, 2015; Guernsey, 2014).
- On average, children ages 2 to 10 years spend more than 2 hours a day with screen media, about half that time viewing materials that parents consider "educational." As they get older, children's screen time increases, but the amount of educational viewing decreases (Common Sense Media, 2017).
- By 2013, nearly three of four children had access to mobile devices at home on which they spent time playing games, using apps, watching videos, and reading books (Common Sense Media, 2013).
- In their teenage years, nearly all 12- to 15-year-olds watch television (98.5%) and use computers (91%), but only one quarter of boys and one third of girls meet an American Academy of Pediatrics–recommended limit of 2 hours a day or less for television plus technology use outside of school (Herrick, et al., 2014).
- **Media multitasking** (using more than one form of media at a time) is another prominent technology use feature among teenagers. The much-publicized *Generation M2* study reported that teens and tweens averaged 7 hours and 38 minutes during a typical day using different types of digital and screen media (computers, video games, music players, television). However, media multitasking means these youngsters were actually experiencing 10 hours and 45 minutes of media time daily (Rideout, Foehr, & Roberts, 2010). Those numbers have not declined in the decade since the publication of the *Generation M2* study; in fact, children and adolescents continue to spend enormous amounts of time with digital and screen media at younger and younger ages.

In 2018, the Harris Poll found dramatic shifts in technology use between **Millennials**—those born after 1981—and those K–12 students who were born after 1996. The results are summarized in Table 1.1. Both groups are immersed in learning with technology, but members of Generation Z show greater preferences for visual media and video learning, interactive apps and websites, and, perhaps surprisingly, in-person group activities.

Increasingly, mobile phones are children and teenagers' most widely accessed technology. Growth in phone technology use has been rapid. By 2013, nearly four out of five 12- to 17-year-olds (78% had a cell phone, while almost half (47%)) owned a smartphone (Lenhart, 2015). Teens use their phones when communicating with friends, using apps, and accessing the Internet for information and other educational purposes. One in four teens are "cell-mostly Internet users" who get information for school almost solely by using their phones; more than half of those youngsters download apps for entertainment or educational purposes. A majority of parents believe mobile devices are tools of the future that should be used to enrich and engage students' learning. Although in about one in five households youngsters do not use any mobile or portable devices, by high school only 1 in 10 students is a non–technology user at home (Grunwald Associates LLC, 2013).

Table 1.1 Technology Preferences for Generation Z and Millennial Learners

Generation Z	Millennials
Social Media • YouTube (82%–67%) • Instagram (70%–45%) • Snapchat (69%–32%) • Twitter (43%–34%)	*Social Media* • Facebook (43%–34%)
Online Visual and Video Sites • Watching movies online (43%–27%) • Visiting video sharing sites (66%–55%) • Playing online games (53%–35%) • Sharing pictures, videos, music (66%–56%)	*Online Visual and Video Sites* • No preferences in this category
Tools for Learning • YouTube (59%–55%) • In-person group activities (57–47%) • Learning apps and interactive sites (47%–41%)	*Tools for Learning* • Books (60%–47%)

SOURCE: Pearson. (2018, August). Beyond millennials: The next generation of learners.

Digital Dialog 1.1

Looking at the Harris Poll survey findings in Table 1.1, college students who are planning to become teachers may find their experiences with technology are closer to the older generation of Millennials than the generation of students you will be teaching when you enter the classroom. Consider whether you align more closely with Gen Z or Millennials in the categories of the survey, then connect and comment online about the following questions:

- Based on what you now know about Gen Z and Gen Alpha, what digital tools might you consider using for teaching to engage your students? Explain why.
- Students use technology in so many parts of their lives outside of school. Should they be constantly connected to technology in the classroom? Why or why not?

MyLab Education
Video Example 1.2
In this video, you will learn how technology offers the potential for transformative change in schools. What technologies are you planning to implement in your teaching that are new and different from those you experienced as a student?

MyLab Education Self-Check 1.1

Technology Today

1.2 Discuss ways teachers utilize digital technologies in their work as educators.

New digital technologies can become essential teaching and learning tools for beginning teachers or experienced educators by creating learning experiences that would not be possible otherwise. Internet-connected computers, tablets, and smartphones offer unparalleled access to information, interactive games, streaming videos, real-world simulations, social media, online communication and collaboration tools, and many more exciting ways to expand the impact of learning in school for students and teachers.

Every **technology**, from simplest to most complex, ancient to most recent, is a tool, device, or material whose purpose is to solve human problems. Technology is a "practice, a technique, or a device for altering the experience of the world," noted historian Rebecca Solnit (2004, p. 114) in her study of how the telegraph, the railroad, high-speed photography, and motion pictures transformed the American West in the late 19th century. Those technologies altered existing social, cultural, economic, and political patterns by extending the nation's industrial base, displacing native peoples from ancestral lands, changing how people experienced the world, and setting a course for the future.

Creating technological solutions to problems facing humans has been happening since the beginnings of humankind. The wheel, stone tools, and rocks crafted into arrowheads are examples from the ancient past. The technology of writing in the form

of written record keeping changed patterns of trade and commerce in the Middle East, Asia, and the Americas thousands of years ago. Beginning in 1450, the printing press transformed European society by making books and newspapers available on a scale never before imagined (Wheeler, 2019). U.S. history is marked by the technological transformations brought about by the cotton gin, interchangeable manufacturing parts, the telegraph and telephone, electricity, television, and most recently, information-processing machines known as computers.

Technologies have continually transformed American education—the first widely used educational textbook, *The New England Primer*, was published in 1690; students in colonial one-room schoolhouses used hornbooks, wooden paddle-shaped devices with reading material pasted on them; the chalkboard dates back to the 1840s; mass-produced paper and lead pencils came into use after 1900; with support from Thomas Edison, among others, teachers started showing educational films as early as 1910; educational radio entered many schools in the 1930s; the first videotape premiered in 1951; the handheld calculator arrived in 1958; and the interactive whiteboard debuted in 1999 (Haran, 2015; Reynolds, 1976).

Importantly, the technologies that became widely used in schools and society before the 1980s were non-digital technologies; that is, they were not connected

Figure 1.2 A Digital Technology Timeline

1980 to 1990	First portable laptop computer (1981) Internet standards for sending and receiving messages (1982) Macintosh computer (1984) Cell phone goes on sale (1984) First one-on-one computing program (1985) Eudora e-mail (1988)
1990 to 2000	PowerPoint released (1990) First digital camera (1991) World Wide Web open to the public (1991) First website published (1991) Mosaic, first widely popular graphical web browser (1993) eBay started (1995) WikiWikiWeb, first wiki (1995) Interactive whiteboards (1997) NetLibrary provides e-books to libraries (1998) Blogs (1999)
2000 to 2010	Microsoft tablet PC (2000) Wikipedia launched (2001) First generation iPod introduced (2001) Skype, iTunes (2003) Facebook (2004) Podcasts online (2004) First YouTube video uploaded (2005) More text messages than telephone calls (2007) iPhone, Twitter, Tumblr, Kindle e-reader (2007) Android smartphone (2008)
2010 to 2020	iPad (2010) Instagram (2010) Digital music outsells CDs for the first time (2011) MOOCs (2012) Game-based learning Digital textbooks Open Education Resources (OERs) 3-D Printing and the maker movement Flipped classrooms Adaptive technologies Digital badges Wearable technologies Augmented reality Virtual reality Mixed reality Adaptive learning Virtual and remote laboratories
Emerging	The Internet of Things (IoT)—devices talking to devices Artificial intelligence (Siri, Twitter bots) Robotics in the classroom Voice-based applications

to computers or the Internet. The shift from non-digital to digital tools marks a modern-day revolution in how technologies are being used in schools. Figure 1.2 shows a timeline of new computer-based educational technologies that have entered schools over the past four decades.

Notice how many of the technologies in Figure 1.2 are very recent developments (i.e., in the past decade), yet it is hard to imagine living or learning without them. As digital technologies become more commonplace, they tend to disappear from our view, as sociologists Bertram Bruce and Maureen Hogan (1998) observed almost two decades ago. People often take everyday technologies for granted, hardly noticing the changes they bring to our lives. Becoming more aware of technology's presence is a crucial first step to understanding its potentials and complexities as educational tools. Not every use of technology is automatically positive or productive. To make the best of technology's possibilities, teachers and students must continually and thoughtfully review and redefine how it is used in schools and society.

Technology changes every aspect of a teacher's work, including lesson planning, recordkeeping, and communicating with students, families, and colleagues.

SOURCE: Shutterstock

Computer Technologies

The modern digital computer is a uniquely powerful form of technology that is changing all aspects of our lives. Before the middle of the 20th century, the word *computer* referred to human beings hired to do work that involved repetitive mathematical computations (Campbell-Kelly, et al., 2013). This type of *computer* was shown, for example, in the 2016 movie *Hidden Figures,* in which the calculations of African American women were essential to launching the first American astronaut into space in 1962.

Today, **computer** refers to an information-processing machine that manipulates data by following instructions of human programmers, millions of times a second, far exceeding human capacity to do the same tasks. Modern computers provide people the ability to store, retrieve, and communicate information in ways never before possible.

The two main components of a computer are hardware and software. **Hardware** refers to the basic machinery and circuitry of a computer. **Software** is the term for computer instructions—a collection of codes that tells the hardware to perform specific functions. Computers have two main types of software. System software is responsible for the overall functioning and control of a computer. It includes the operating system, network operating system, database managers, and teleprocessing (TP) monitor. Application software performs specific functions in specialized ways to produce a variety of services, including word processing, presentation design, music playing, Internet browsing, e-mail management, or movie making, to name a few. You will recognize many of these programs by their commercial names: Microsoft Word, Microsoft PowerPoint, Adobe Acrobat, Adobe Photoshop, Norton Antivirus, and so on. Sometimes programs are bundled together in one large productivity package, such as Microsoft Office Home and Student.

Standard software applications are indispensable tools for every computer user. For example, we cannot imagine writing this book without the speed and other functions of word processing. We are reliant on Microsoft Word's features to organize, draft, revise, and format our chapters. Writers are not alone in their need for computerized tools; accountants need tax preparation software, architects need design programs, physicians need patient data tracking tools, and weather forecasters need programs to provide interactive models of meteorological patterns.

Digital Dialog 1.2

Interviewed in 2012 by researchers from the Pew Internet & American Life Project, more than 1000 education and social policy experts concluded that technology's future impact on people and society will be generally positive (Anderson, 2012). Thinking about the impact of technology today on your own life and society as a whole, comment and connect online about the following questions:

- How might the future impact of technology on the learning behaviors and thinking patterns of students be positive? Negative? Why?
- What technologies do teachers need to use to successfully teach today's students?
- How can educational technologies enable teachers to promote learning success for all students?

From Web 1.0 to Web 2.0/3.0

The Internet in the form of the World Wide Web, observed history podcaster Brian McCullough (2018), "is the reason that computers actually became useful for the average person." The web is essentially a network of networks, more than 1 billion websites linked to one another and accessible through powerful computer-based search engines. While only about 25% of all websites are active, those sites contain an almost infinite amount of information. In 2015, one *Washington Post* newspaper reporter estimated that to print out the entire Internet would take 305.5 billion pages of paper—the equivalent of 212 million copies of Leo Tolstoy's classic novel *War and Peace* (Dewey, 2015). Yet teachers and students and anyone else with an Internet-connected computer can access whatever amount of this information they want to acquire.

The Internet of today is not the Internet that first became publicly available in the early 1990s. **Web 2.0/Web 3.0** denote how the Internet has evolved into a more open medium capable of promoting interaction and collaboration among teachers and students. While the early Internet (Web 1.0) was dominated by content developed by experts, Web 2.0/Web 3.0 are marked by widely shared, frequently changing information provided through easy-to-use Internet websites and mobile phone applications.

Experts do not agree about a precise distinction between Web 2.0 and Web 3.0; in general, Web 2.0 technologies include blogs, wikis, podcasts, social bookmarking and **social networking** tools, inquiry-based educational websites, photo-sharing websites, virtual worlds, and other highly interactive tools and services that are now becoming resources for teaching and learning in schools (Richardson, 2011). Interactive web tools have given rise to what Harvard University Professor Christopher Dede (2008) called **Web 2.0 knowledge**—bottom-up, democratically derived, consensus-driven ideas and information that differ dramatically from the theoretical knowledge created by experts and elites.

As Web 2.0 evolves to Web 3.0 past the year 2025, forecasters say technologies will be more closely networked together as new systems emerge with broadband access speeds 50 to 100 times faster than the average connection today (Rainie, Anderson, & Connolly, 2014). Devices will respond to voice and touch commands; embedded and wearable devices will provide immediate feedback to improve personal well-being and social life; information will be shared seamlessly across the globe, giving everyone wider access to human knowledge—all part of the Internet of Things (Anderson & Rainie, 2014b). Complexities will arise—unforeseen and unintended consequences of technology's growth will create new problems, especially for those groups who are left behind the pace of change (Anderson & Rainie, 2014a).

As the Web evolves into an ever-more expansive component of people's everyday lives, one of the overriding challenges for educators is teaching students the skills to critically analyze and respond to change as technology expands, evolves, and engages them in the next decade and beyond. Tech Tool 1.1 looks at three integral **information and communication technologies** for teaching: tablets, smartphones, and laptops.

Tech Tool 1.1

Tablets, Smartphones, and Laptops

As a college student, you may own a smartphone as well as a laptop, desktop, or tablet computer. By 2018, 95% of all Americans owned a cell phone; 75% had smartphones; three in four owned a desktop or laptop computer; half had a tablet; one in five had an e-reading device (Pew Research Center, 2018). Mobile and digital technologies provide anywhere, anytime online access to ideas, information, and learning resources—essential features of educational life for teachers and students. The three basic mobile devices include:

Tablets

Tablets are small, powerful machines that use touch-screen controls and Internet access to promote interactive learning among teachers and students who can collaborate on projects, share information, access multimedia resources, compute and calculate numbers, and perform many other learning activities. The Apple iPad (multiple models), Microsoft Surface Pro, Samsung Galaxy Tab S4, and Asus ZenPad are all highly rated tablets. The definition of what is or what is not a tablet is evolving, giving rise to a new term, *phablet*, meaning a device that combines features of a tablet and a mobile phone. Its larger size screen hosts full high definition with superior resolution for online browsing, music listening, photo taking, movie and video viewing, and e-reading.

Smartphones

Smartphones are mobile telephones that perform a range of information communication functions, including Internet access, voice communication, text messaging, and video viewing. As historian Paul Ceruzzi (2012) noted, smartphones blend the functions of technologies from the past—telephone, radio, television, phonograph, camera, and teletype—to create a multifunctional handheld device. Apple's iPhone propelled the development of smartphone technology, and now there are numerous competing models from multiple companies.

The smartphone's popularity opens up many possibilities as a learning technology. First, smartphones support anywhere, anytime learning. Teachers and students can access a wealth of audio and video educational resources whenever they choose. Second, the portability of a smartphone lets students take course content wherever they go. Third, teachers and students can record their own podcasts and then listen to them on their phones. Although not yet total substitutes for desktops and laptops, smartphones offer on-the-go teacher options such as rapid note taking, quick texting and e-mail communicating, and easy information searching. Like tablets, smartphones run many apps for educational learning.

Laptops

Laptops (also called *notebooks, netbooks,* or *ultrabooks*) weigh between 2 and 8 pounds. Although their lightness is a significant bonus, the computing power of these machines makes them vitally useful for teachers. High-quality laptops offer long battery life, an easy-to-read screen display in all kinds of light, sufficient memory to run multiple applications, and enough processing speed to handle downloading information and processing files. They have enough storage to be filing cabinets and virtual libraries. Ask yourself, "What kind of laptop user am I?" If you are a frequent note taker, you may want to consider battery life. If you do lots of traveling, weight may be your number-one concern. If you store lots of data, memory may be your purchasing focus.

Tablets, smartphones, and laptops run apps, support software, and access interactive websites that can be used for thousands of instructional purposes:

- Supporting learning in every subject area—interactive world maps in social studies, online dictionaries and poetry collections in language arts, calculators and problem-solving activities in math
- Asking students to research existing apps that specifically address the needs of people in local communities
- Inviting students to envision new smartphone apps to explore pressing social or environmental problems.

MyLab Education **Application Exercise 1.1:**
Transforming Technology Tools for Tablets, Smartphones, and Computers

MyLab Education **Self-Check 1.2**

Highly Interactive, Inquiry-Based Teaching and Learning with Technology

1.3 Analyze how 21st century technologies can be used to create highly interactive, inquiry-based learning environments.

In today's technological age, teachers have much more to teach than just the basics of reading, writing, math, and science. To prepare students for productive lives and

fulfilling careers, teachers are expected to use technology to convey digital-age skills to students through **highly interactive, inquiry-based learning**. *Highly interactive* means organizing educational activities in which students and teachers are actively involved in using technology to create and evaluate their educational experiences. *Inquiry-based* means preparing, delivering, and assessing lessons differently, helping students to think critically and creatively about the learning they do and the technologies they use. In highly interactive, inquiry-based classrooms, students move from being mainly consumers of ideas and information to becoming creators of knowledge using technology.

The following ideas and concepts are central to understanding how technology can be used to transform classrooms into centers of interactive teaching and active learning.

Updating Bloom's Taxonomy with Technology

Bloom's taxonomy is a seminal educational classification first presented in 1956, revised in 2002, and re-envisioned for a digital age in 2008 (see Figure 1.3).

Bloom's taxonomy consists of six levels of thinking skills ranging from lower order to higher order. When first proposed, its original thinking levels were knowledge, comprehension, application, analysis, synthesis, and evaluation. The skills are now expressed using action-oriented verbs: remembering, understanding, applying, analyzing, evaluating, and creating (Krathwohl, 2002).

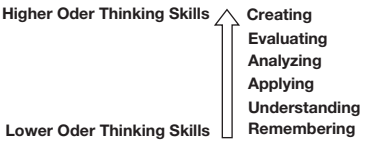
Each thinking skill indicates what students do intellectually at each level. **Lower order thinking** skills involve students recalling and understanding academic information; **higher order thinking** skills involve students applying their understanding of information through analysis, evaluation, and creative actions: Remembering focuses on information recall and recognition. Understanding means deriving meaning from information. Applying involves using what one has remembered or understood in new situations. Analyzing results when learners examine a situation or a problem to arrive at a solution. Evaluating means making an assessment based on set criteria. Creating happens by making something new based on what is being learned (Ormrod, et al., 2017).

Commentators now propose that digital technologies can support different thinking skills; for example, social bookmarking tools can support remembering while podcasting is a form of creating (Churches, 2008). While it is true that technology can support and develop students' higher order thinking skills, the "capacity for transformation is not intrinsic to the technology itself," as Nicholas Burbules and Thomas Callister Jr. (2000, p. 7) noted more than two decades ago. Adding computers to a classroom or requiring students to use digital tools in their assignments is not what will change education. Only as teachers and students adopt new attitudes and behaviors will schools change in meaningful ways. By itself, technology cannot remake schools or learning, but teachers and students using technology creatively and expansively will generate new directions for learning across grade levels and the curriculum.

Technologies can be evaluated in terms of how they promote higher order or lower order thinking by students. For example, technologies can be used in ways that are "highly transformative," "moderately transformative," or "minimally transformative":

- Highly transformative (5–6 stars): The resource is open-ended and allows users to think critically and solve problems using ideas and explorations. The resource emphasizes creating and evaluating, the top two higher order thinking skills on Bloom's taxonomy.
- Moderately transformative (3–4 stars): The resource offers pre-set and guided explorations that structure how users engage with the material. The resource emphasizes analyzing and applying, the middle two higher order thinking skills on Bloom's taxonomy.
- Minimally transformative (1–2 stars): The resource offers mainly drill and practice activities that provide little variety for users. The resource emphasizes remembering and applying, the bottom two lower order thinking skills on Bloom's taxonomy.

Figure 1.3 Bloom's Taxonomy



Digital tools transform the learning experience in today's classrooms.

SOURCE: Annie Fuller/Pearson Education

There are many useful online resources for learning more about Bloom's taxonomy. Fresno State University has published a collection of action verbs for teachers to use when designing learning activities for each thinking skill. There is an interactive version of the taxonomy available from the Iowa State University Center for Excellence in Learning and Teaching. New Zealand educator Andrew Churches has posted a digital taxonomy connecting specific technology-based activities to each of Bloom's thinking skills.

21st Century Skills

The term **21st century skills** represents the knowledge and understandings that students will need to succeed in our highly technological, information-based society. These skills include the ability to think critically, make informed judgments, solve complex problems, think creatively, communicate and collaborate with others, use information in innovative ways, and take responsibility for one's personal and civic life (Figure 1.4). Each skill propels students from passively receiving information from technology to actively creating knowledge and talents with technology.

Teaching skills is not new; schools have always prepared students for life and work, but not in the same ways for everyone. Looking back at schooling for more than a century, historian Diane Ravitch (2000, p. 14) noted, "The great educational issues of the twentieth century in the United States centered on questions of who was to be educated and what were they to learn." Public schools in the late 19th and 20th centuries focused on preparing working-class and immigrant students for roles as workers in an industrial society, emphasizing the skills and knowledge of vocational education and domestic work (Tyack, 1974; Cremin, 1988). Those from backgrounds of wealth and privilege followed very different educational pathways, from elite schools to positions of leadership in industrial America.

By the mid-1980s, however, the number of U.S. professional, managerial, and technical workers exceeded the number of manufacturing workers for the first time—just

Figure 1.4 A Diagram of 21st Century Skills

SOURCE: Partnership for 21st Century Skills (P21), www.p21.org. Used with permission.

as manufacturing workers had exceeded those who worked on farms for the first time around the turn of the 20th century. Society was then transformed by the computer revolution that reached into every aspect of American life. "Information technology changes everything," declared William E. Halal more than a decade ago, and as "computer power continues to rise exponentially, and artificial intelligence (AI) becomes human-like, all this capacity will soon allow almost any social function to be performed online" (2008, p. 59).

Since that time, many students—particularly those from low-income and non-White families—have not achieved the higher levels of educational attainment needed for life and careers in today's society. Without higher levels of education, they lack the skills needed in an increasingly information- and technology-based society, and they find themselves trapped in low-skill/low-wage jobs. Educational inequality leads to economic inequality. Ideally, 21st century skills result from schools where every student learns the knowledge, competencies, skills, and habits of mind needed for current and future careers and workplaces.

The National Council of Teachers of English (NCTE; 2007, 2008b) has issued its own definition of skills students will need for the future, called **21st century literacies**. To live and work successfully, students must have the basic competencies of reading, writing, and mathematics, as well as an array of technology-based literacies, including proficiency with technology tools, the ability to build relationships and solve problems collaboratively, the knowledge to design and share information, the capacity to analyze and evaluate information from multiple sources, and the capability to handle information in ethical ways. "These literacies—from reading online newspapers to participating in virtual classrooms—are multiple, dynamic, and malleable" (National Council of Teachers of English, 2008b).

There are two key concepts that are essential to understanding 21st century skills: 1) technological pedagogical content knowledge (TPACK), and 2) the ISTE (International Society for Technology in Education) Standards for Students and Educators.

MyLab Education
Video Example 1.3
In this video, you will learn how one high school is connecting academic learning to the solving of real-world problems. How can technology be used in schools like this to further promote 21st century learning?
https://edisonhs.fcps.edu/academics/stem

Technological Pedagogical Content Knowledge

Technological pedagogical content knowledge (TPACK) proposes ways 21st century skills can be taught through **21st century technologies** (TPACK & Koehler, 2014). Through TPACK, teachers bring together three different forms of knowledge to produce powerful learning experiences for students:

1. *Content knowledge* includes the essential academic subject matter that teachers must convey to students in elementary or secondary schools.
2. *Pedagogical knowledge* includes all information that teachers know about teaching methods, instructional design, curriculum development, and how different students think and learn.
3. *Technological knowledge* includes knowing how to use multiple types of technologies in teaching, from books, manipulatives, and whiteboards to computer- and Internet-based Web 2.0 tools.

To be successful leaders in today's schools, teachers must blend all three forms of knowledge in ways that meet different instructional and student needs as follows:

- Academic content combined with technology creates technological content knowledge that shows teachers how to use technology to communicate content to students.
- Pedagogical knowledge combined with academic content knowledge becomes pedagogical content knowledge through which teachers understand how to use different methods of teaching to engage students.
- Combining content, pedagogy, and technology produces the technological pedagogical content knowledge that can guide the effective teaching of students with 21st century technology tools.

ISTE Standards for Educators and Students

The International Society for Technology in Education (ISTE) is the leading technology organization in the country, and its educational standards guide the use of technology in K–12 school systems, as well as in college and university teacher preparation programs around the country. ISTE's first standards, National Educational Technology Standards (NETS), were issued in 1998, followed by standards for teachers and administrators in 2000 and 2001. Those early standards focused on students learning basic technology skills, at the time called "computer literacy." Revised standards for students and teachers came out in 2007 and 2008, and those focused on ways to successfully integrate technology into classroom learning.

A decade later, ISTE has refreshed and updated its standards for students and educators once again to stress using technology for highly interactive and inquiry-based teaching and learning. To generate next-generation learning environments, the latest **ISTE Standards for Students** (2016) identify seven roles for students: Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator, and Global Collaborator. Each of these roles is intended to "empower student voice and ensure that learning is a student-driven process of exploration, creativity and discovery no matter where students or teachers are in the thoughtful integration of technology" (Aglio & Gusky, 2017).

To support its standards for students, **ISTE Standards for Educators** (2017) set forth seven roles for teachers: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst. While stating that these roles are not "technology standards" per se, ISTE states that they "set the vision for how educators can use technology to create next-generation learning environments" (quoted in Smith, 2017). The first five chapters of this book are aligned to the ISTE Standards for Educators. The last seven chapters are aligned to the ISTE Standards for Students.

ISTE believes its updated standards for students and teachers "provide a framework for learning, teaching and leading that is amplified by technology" (ISTE Team, 2017). *Amplify* is the key word here. To amplify is to make larger, to expand, to present more broadly and expansively. Just like surround-sound speakers bring the audio experience of a concert, a movie, or a classroom presentation to whole new levels for audiences, ISTE believes that technology can bring the experience of teaching and learning to whole new levels for educators and students. The goal becomes how to achieve these new levels. Technology creates learning experiences that would not be possible without it, providing unparalleled access to information, unprecedented amounts of interactivity, unsurpassed levels of communication, and unmatched capacities for creative self-expressions, along with many more ways to impact education at all grade levels.

In ISTE's vision, technology is not a curriculum add-on or an individual reward that students get only after completing other assignments. Nor is it the "end all/be all" of the instructional process. Rather, technologies function as tools for learning—vehicles for focusing student thinking on important ideas while discovering what they can create or invent through hands-on/minds on activities. Digital tools let teachers and students together create and design, explore and express, imagine and envision—while incorporating ideas and concepts that are part of the required academic curriculum. When using technology in classrooms, said one educator, "it's about the teaching, not the tools" (Stoeckl, 2016).

As a digital age teacher, your goal is to use 21st century technologies to create interactive and inquiry-based learning experiences that teach academic content as well as literacy and learning skills to K–12 students. All the ideas, activities, and materials you use with students, from textbooks to group activities to new technologies, are the instruments of that goal. As a teacher, you are the person who puts these elements into action, blending them in ways that generate exciting, challenging, and memorable learning experiences for students. You can discover how one teacher builds a lesson around the ISTE Standards for Students in this chapter's In Practice.

In Practice

Envisioning New Water Conservation Technologies: An ISTE Standards for Students Learning Activity

Grade Level	Featured Technologies
Upper Elementary and Middle School	Interactive websites, 3-D Modeling Software, 3-D Printers, Presentation Tools

Lesson Outline

The seventh-grade social studies curriculum at the middle school where Irene teaches emphasizes addressing state curriculum standards through thematic teaching, student-centered instruction, and the integration of digital technologies. In a learning activity on water-saving technologies, Irene integrated the latest ISTE Standards for Students—Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator, Global Collaborator.

To explore Central and South Asia as part of the world geography curriculum, Irene decided to focus on water use and conservation as a core theme through a unit titled "Water Conservation Technologies." The United Nations 2015 World Water Development report forecasts that 40% of the world's population will lack access to usable water by 2030. The goal of Irene's lesson was for students to understand the life-threatening issues faced by people who live in the regions of the world where access to clean water is neither readily found nor easily maintained. Climate (arid lands/rainy followed by dry seasons) and human actions (population growth/pollution/environmental exploitation) dramatically impact the availability and quality of water.

Teaching with Technology

While countries and cities throughout Central and South Asia face severe water shortages every day, the water crisis impacts people in United States and the families in Irene's school community as well. A 2016 U.S. Geological Survey report identified her state as being at high risk of having toxic metals in household pipes leach into drinking water supplies. High levels of lead were also found in more than 1,000 schools around the state. Utilizing the ISTE standards of Knowledge Constructor and Empowered Learner, the students and Irene began the unit by calculating their personal water footprint use with an online tool from the Grace Communications Foundation. The Nature Conservancy estimates that the average water use of an American is equivalent to 32,911 glasses a day—96% of which goes to growing food, making clothes and everyday items, and producing energy. Integrating math learning, students compared their daily use of water with that of people throughout the United States and around the world.

Irene next introduced students to the concept of greywater—water that has been used but is not done being useful thereafter. Water from sinks, washing machines, showers and tubs are common examples of greywater. When one student asked if it were possible to reuse the water the class used to wash hands and flush toilets to reduce overall water consumption, Irene suggested the class design ways for this to happen. Soon, students offered more ideas for how water could be used more efficiently and less wastefully. Leaky pipes that carry water from reservoirs to cities could be repaired or replaced; seawater could be repurposed through desalination; rainwater could be harvested for irrigation; composting toilets could be installed in public facilities.

Implementing the ISTE Innovative Designer and Computational Thinker standards, Irene challenged individuals and small groups to create engineering designs for their water conservation ideas. Students had the option of using physical materials (paper, cardboard, glue, tape, and other supplies) or 3-D modeling software to display their designs. More than a dozen students chose to use Tinkercad, a software program, for their designs, which could then be sent to a local college library where the digital code could be transformed into a hands-on model by a 3-D printer.

Finally, in the roles of ISTE Creative Communicators and Global Collaborators, students shared the results of their projects through different forms of media, including written reports, digital presentations, and short videos. Students' projects were posted on the class website so people locally and globally could access and learn from what the students proposed could be done to improve water safety and availability. Students found the project and its various technology connections personally meaningful to them as learners. One youngster commented: "In school, when we have a project and they give you a set of rules, sometimes these projects don't show any skills that I have. . . . 3-D printing lets you use your imagination." Another said that 3-D modeling "portrayed what we were trying to get across in a different way." Summarizing the full experience from an ISTE Digital Citizen perspective, a third student remarked how "everyone was talking about problems, but no one was talking about solutions." Now an entire class had ideas and proposals to solve real-life problems.

MyLab Education Self Check 1.3

Building a Professional Learning Network

1.4 Organize a professional learning network (PLN) as a technology-using educator.

MyLab Education
Video Example 1.4

In this video, long-time educator Rita Pierson describes why every kid needs an adult who believes in them and their potential. How can you use your PLN to become a teacher who is a champion for students?
https://www.ted.com/talks/rita_pierson_every_kid_needs_a_champion?utm_expid=166907-24&utm_referrer=http%3A%2F%2Fwww.ted.com%2F

To become a technology learning and leading educator, you will benefit by organizing a **professional learning network (PLN)**—an anywhere, anytime source of ideas and information that supports and expands your talents and competencies as a teaching professional. A PLN is a multifaceted system of people (e.g., colleagues, Twitter contacts), spaces (e.g., conferences, Facebook groups), and tools (e.g., listservs, information curation sites) that support ongoing learning and professional growth. It serves as a way for you to keep expanding what you know how to do instructionally and professionally with interactive digital tools and educational change ideas (Trust, Carpenter, & Krutka, 2018; Trust, 2012). It directs and connects all the ways you obtain ideas, resources, materials, and connections.

A PLN is an extension of the term *personal learning network*, which has been defined as a "set of connections to people and resources, both offline and online, who enrich our learning" (Richardson & Mancabelli, 2011, p. 2). Personal learning networks include family, friends, and associates with whom we interact during our lives, as well as the media and information sources we use to gain ideas and information. These personal networks evolve dynamically as you meet new people and participate in new experiences.

A professional learning network acknowledges that teachers—like doctors, artists, dancers, scientists, engineers, designers, musicians, and other professionals—are learners for a lifetime. Being a lifelong learner gives teaching vitality and creativity as a profession, and it sustains a career filled with long working hours in schools. Teachers experience joy and accomplishment from teaching students and learning new ideas and information that support their work as educators. A PLN demonstrates your commitment to being an innovative, future-focused teacher, declaring, "I am serious about learning, personally and professionally, and sharing ideas and resources with students and colleagues." It is also a way to demonstrate to superintendents and principals that you possess knowledge, skills, preparation and forward thinking to apply for a job as a full-time classroom teacher. As one college student wrote to us:

> *I just wanted to let you know that I included my PLN padlets* [a virtual bulletin board] *on a job application to a social studies position, and in the past week I had an interview and they just offered me the job! They mentioned that the padlets really helped them get to know my values as a teacher and see all of the skills and resources that I have—I think it really helped me stand out from the crowd. I landed my dream job!!*

Your "Must Know About" Technologies

Digital technologies will be central to your work as a teacher and central to the learning of students who are daily users of multiple technology devices. Imagine you are beginning your teaching career next week. What might be your "must know about" technologies for 21st century teaching?

In answering this question, some of you might cite subject specific technologies such as the dual visualization tool TinkerPlots for mathematics teachers, a Google Lens camera-based augmented reality app for science teachers, or iCivics interactive games for social studies teachers. Others will list tools like presentation software, social media, and video-making apps that can be used across the disciplines and the grade levels. Understanding and being able to utilize your "must know about" technologies as teaching and learning tools is a prime reason for creating a PLN.

In 2008 when we asked Michael Flynn, a Massachusetts State Teacher of the Year and winner of a Presidential Award for Excellence in Mathematics Teaching, for his "must know about" technologies, he listed a laptop, an interactive whiteboard, a student participation system with clickers, and a smartphone. He used these tools to create

Table 1.2 Types of Educational Technologies

Physical devices	Online references	Software and apps	Online tools	Social media tools
Computers Smartphones Tablets Video cameras 3-D Printers Audio recorders Remote control drones Robotics kits	The Internet Web-based maps (e.g., Google Maps) Infographics Interactive charts Online archives (e.g., Library of Congress)	Word processing Presentation tools Animation tools Spreadsheets 3-D modeling Digital assistant (e.g., Siri, Alexa)	Blogs Wikis Multiplayer games Virtual worlds Wikipedia Infographic builder Screen capture Survey tools Multimedia messaging	Twitter Pinterest Facebook Instagram Video posting (e.g., YouTube, Vimeo)

small-group alternatives to whole-class instruction, to activate student engagement with learning, to differentiate instruction, and to produce interest-building, problem-solving experiences in language arts, math, science, and history. He recognized then that every teacher will be constantly learning to use new technologies throughout their career to continue creating unique, powerful, and transformative learning by students.

Now, more than a decade later, "must know about" technologies are much more than the newest mobile phone, computing machine, or classroom tool. Instructional Technologist Fred Zinn has listed five types of educational technologies that teachers should learn about as teaching and learning tools (see Table 1.2):

Technologies in the five categories may be categorized by one of three levels indicating how they are used by teachers:

- Level 1 (*Old-School Tools*): Teachers are familiar with these technologies and use them regularly.
- Level 2 (*Current Devices*): Teachers may be somewhat familiar with these technologies and/or may need time to learn how to use them effectively.
- Level 3 (*Emerging Technologies*): Teachers are unfamiliar with these technologies and will need time to learn and use them.

In this framework, presentation software (Google Slides, PowerPoint, Keynote) is a Level 1 tool because it has been used regularly in schools for years. By contrast, online survey tools (Google Forms), virtual worlds (Minecraft), or online programming, coding and robotics resources are at Level 2 or Level 3, depending on whether they are part of current or future instructional practices by teachers.

You will be utilizing these five kinds of technologies for multiple purposes:

- *Instructionally* for activities you conduct directly with students, such as class presentations, multimedia demonstrations, and group projects and activities
- *Professionally* for activities you do to support teaching, such as lesson planning, person-to-person communications, and grade and record keeping
- *Interactively* for activities you create that involve students in learning in face-to-face and online settings.

As a new teacher getting ready to enter the teaching job market, you will want to know about and be able to use technologies from all three levels. You will want to be conversant and confident with tools that are considered old-school (Level 1) as well as technologies that are either current or emerging educational practices (Level 2 and Level 3). That way, you are prepared for what is and what will be available in the field of educational technology.

Push and Pull Technologies

The far-reaching influence of a PLN emerges through the ways you use online **technologies**. The web is a vast stream of information where individuals and organizations constantly offer resources and materials to technology users using **push technologies**). From all that available information, people select specific resources

Table 1.3 Robert's Push/Pull Information Flow

Information to the Web (Push)	Information from the Web (Pull)
Teacher-created websites and wikis	Online searches
Teacher-written blog posts	E-mail inquiries and blog post requests
Teacher-made videos and podcasts	Information alerts and updates
Teacher-made presentation slides and notes	Online journal articles
Personal resume and professional portfolio	News headlines sent to smartphones

and materials using **pull technologies**). Learning about the weather is one example of push and pull technologies. Television stations, online organizations, and interested individuals provide (push) weather news to the web every day for people to access (pull) as sources for information.

Teachers continually pull information from the web to expand academic content knowledge, build lesson plans, assess student learning, and stay current with educational trends and policies, and they constantly push information to students, colleagues, families, and school administrators—making themselves information seekers and information providers.

Table 1.3 shows how one history teacher uses push and pull technologies in his professional learning network.

- *Push*: Robert provides educational information to students and colleagues by posting links to blogs, videos, podcasts, and his online professional portfolio on the homepage of his teacher website. He also contributes to wikis for teachers and tutors, making his research available to interested readers worldwide.
- *Pull*: Robert receives ideas and resources from online information searches, professional learning communities, and information alerts in his e-mail from a global network of history teachers using the Diigo social networking site to offer each other links to new curriculum resources.

Like Robert, you can organize the push and pull of information from multiple sources to help construct your professional learning network.

Components of a Professional Learning Network

Building a professional learning network through the push and pull of information establishes three features of your identity as a technology-using educator:

- *Multimedia resume.* Your PLN presents an evolving portrait of your ideas and talents as a teacher. It shows everyone—from a school district's hiring committees to colleagues, families, and students—that you are a 21st century education professional with the knowledge, talents, and values of a technology-using educator.
- *Teaching and learning activities.* Your PLN showcases your teaching skills, your use of interactive technologies to create engaging lessons and deliver lively instruction, and your readiness to conduct thoughtful assessments of student learning. It provides evidence that you use the web to collaborate with students, post assignments, provide feedback, and invite learning to extend beyond the school day.
- *Technology modeling for students.* Your PLN offers students a model for using technology independently, creatively, and appropriately for learning. From the diverse ways that you use multiple technologies professionally, students observe examples of what it means to be technologically literate, ethical, and safe. As they build their own learning networks, students learn firsthand about the roles and responsibilities of engaged citizens in an information-based society who use technology wisely and effectively for everyone's betterment.

In each chapter, you will find a Building Your Professional Learning Network Application Activity that serves as a feature of your PLN. These activities are designed to introduce new strategies and methods to your teaching, helping you to

integrate technology into learning. We invite you to join us in exploring how digital technologies can realize the possibilities of change for you as a teacher/leader and for students as learners, problem solvers, and critical thinkers in the world of today and tomorrow. You can also learn more about professional learning networks at PLNs for Educators, an open online course developed by Torrey Trust and students at the University of Massachusetts Amherst, free online at https://blogs.umass.edu/plncourse/.

MyLab Education Application Exercise 1.2:
Building Your PLN—Selecting Professional Pull and Push Resources
In each chapter, you will find a Building Your Professional Learning Network application exercise that serves as a feature of your PLN. These activities are designed to introduce new strategies and methods to your teaching, helping you to integrate technology into learning.

MyLab Education Self-Check 1.4

Chapter Summary

Learning Outcome 1.1

Summarize the changing diversity of American education and the roles of technology in the lives of students and families.

- American schools are increasingly more culturally and linguistically diverse settings.
- Academic achievement gaps, as well as connectivity and participation gaps, continue to serve as barriers to learning for students who are living in poverty, have special educational needs, or are speaking English as a new language.
- Students today grow up immersed in technology, experiencing a "digital childhood" and becoming a generation of technology users in their teens.
- Most 8- to 18-year-olds access some type of digital or screen technology almost every waking hour outside of school.

Learning Outcome 1.2

Discuss ways teachers utilize digital technologies in their work as educators.

- Every technology, from simplest to most complex, ancient to most recent, is a tool, device, or material whose purpose is to solve human problems.
- Technology is producing profound changes in every aspect of modern society, transforming how children and teachers live in, interact with, and understand their world.
- Web 2.0 tools are a new generation of technologies that can be used to create highly interactive, inquiry-based learning experiences at all grade levels.
- To become technology-using educators, teachers must continue to learn about their "must know about" technologies.

Learning Outcome 1.3

Analyze how 21st century technologies can be used to create highly interactive, inquiry-based learning environments.

- Twenty-first century skills represent the knowledge and understandings that students need to live and work in today's digital age.
- Technological pedagogical content knowledge happens when teachers combine grade-level subject matter with technology to produce engaging teaching and learning activities in classrooms.
- The ISTE Standards for Educators and Students show teachers how to integrate 21st century digital resources into all aspects of teaching and learning to create alternatives to traditional educational practices by promoting high levels of interaction, engagement, and collaborative learning.

Learning Outcome 1.4

Organize a professional learning network (PLN) as a technology-using educator.

- As a teacher, your PLN includes your technology skills and talents, the ways you integrate technology in your teaching, and how you model technology use for students.
- A PLN is a way to achieve three essential goals as a teacher: a multimedia resume, a space for learning and teaching resources, and a model of technology use for students.

Key Terms

Apps, p. 3
Achievement gaps, p. 4
Bloom's taxonomy, p. 13
Computer, p. 10
Connectivity gaps, p. 5
Digital childhood, p. 7
Digital inequality, p. 5
Diversity explosion, p. 4
Generation Alpha, p. 7
Generation Z, p. 7
Hardware, p. 10
Higher order thinking, p. 13
Highly interactive, inquiry-based learning, p. 13
Homework gaps, p. 5
Information and communication technologies (ICTs), p. 11
ISTE Standards for Educators, p. 16
ISTE Standards for Students, p. 16
Laptops, p. 12
Lower order thinking, p. 13
Media multitasking, p. 7
Millennials, p. 7
Online learning environments, p. 6
Participation gaps, p. 6
Professional learning network (PLN), p. 18
Push and pull technologies, p. 19–20
Smartphones, p. 12
Software, p. 10
Social media, p. 3
Social networking, p. 11
Tablets, p. 12
Technological pedagogical content knowledge (TPACK), p. 15
Technology, p. 8
21st century literacies, p. 15
21st century skills, p. 14
21st century technologies, p. 15
Web 2.0 knowledge, p. 11
Web 2.0/Web 3.0, p. 11

MyLab Education Application Exercise 1.3:
Growing and Leading with Technology: Marco's "PLN Building" Activity

For Reflection and Discussion

Life Before Computers

One way to understand the role of computers in schools and in society is to imagine what people would do if that technology did not exist. Widespread use of computers is a very recent phenomenon. Ask parents, grandparents, and other family and community members to recall how people did things before we had word processing software, e-mail, online banking and shopping, mobile phones, digital cameras, or other digital devices that have revolutionized our lives. What has changed, and has anything remained the same?

The Hype Cycle for Emerging Technologies

The Hype Cycle for Emerging Technologies, from the technology analytics firm Gartner, projects where various new technologies are on a growth and adoption continuum that ranges from initial appearance to long-term use or obsolescence. The cycle has five stages that play out over 5 years in the life of a new technology: innovation trigger; peak of inflated experiences; trough of disillusionment; slope of enlightenment; and plateau of productivity. According to the cycle, after an exciting new technology emerges in the marketplace, people's expectations rise, often to unrealistic heights, before disillusionment sets in and expectations plummet. The technology then either vanishes from the scene (replaced by a better product) or rebounds from its fall to reach a middle ground where it becomes a productive feature of everyday life. For example, the 2017 Hype Cycle had virtual personal assistants (e.g., Siri, Alexa) and autonomous vehicles (driverless cars) high on the peak of expectations, augmented reality dipping into disillusionment, and virtual reality moving toward mainstream adoption.

Consider the latest new technologies that you have begun using or that you have heard about in the news. What do you think will be the potential hype cycle for each of these tools—both in schools and in society?

Replacing People with Machines

Efforts by states around the country to replace human court reporters—stenographers who record testimonies, arguments, and sidebar discussions during trials—with digital recording equipment represent an example of how technology replaces jobs formerly done by people (Crimaldi, 2018). There are many other examples, including telephone switchboard operators, bank tellers, highway toll collectors, pharmacy technicians, travel agents, film projectionists, receptionists, and cashiers at many stores. As you think about the impacts of technology on people and jobs, consider the following questions:

- In what other everyday activities are machines replacing humans? What advantages and drawbacks do you see when technology restructures jobs formerly done by human workers?
- What jobs and careers are most likely to change because of technology in the next decade? Which ones are least likely to change?
- How might teaching change, and how might it stay the same in a digital age?

Chapter 2

Understanding Educational Technology Issues and Trends

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Chapter Overview

Chapter 2 explores educational technology in K–12 schools through a series of five short surveys about the key issues and trends you will encounter as a technology-using educator. Responding to the surveys will help you consider how technology inspires learning and creativity for students, a goal of the ISTE Standards for Educators and Students.

Following each survey is a brief review explaining how educators and researchers are thinking about technology in schools today. These commentaries address the "Learner" domain of the ISTE Standard for Educators that asks teachers and future teachers to stay current with research that supports improved student learning outcomes and then apply that research to their instructional and professional practices. The questions are designed so teachers can discuss them with students, as well as to establish dialogs about technology and its roles in teaching and learning in schools.

Learning Outcomes

After reading this chapter, you will be able to:

2.1 Assess your motivations for becoming a technology-using teacher.

2.2 Analyze barriers to the use of technology in schools, including digital inequalities, achievement gaps, and online safety and digital privacy issues.

2.3 Describe roles for technology in teaching.

2.4 Evaluate how technology supports different teaching philosophies and instructional methods.

2.5 Compare students' technology use in their daily lives and in schools.

Chapter Learning Goal

Analyze key issues and trends in the field of educational technology while assessing your readiness to become a technology-using educator.

Featured Technologies

Computers
Smartphones
Tablets
Apps
Internet
One-to-one computing
Online educational resources

Three Future Teachers Discuss Technology

Donasha, Max, and Ava, all college students preparing to become teachers, were together in the college library completing an assignment for their educational technology course. They viewed a TED-Ed video of a veteran and a beginner teacher using apps in a poetry lesson with second-graders. Then they consulted online databases to research educational theories for a class presentation incorporating audio, video, and animation. On break, they walked to the café in the lobby. As they waited in line, Donasha read her Twitter feed on her tablet, Max checked texts on his smartphone, and Ava previewed the latest science news with her laptop. Over coffee, they began discussing how they planned to use technology as first-year teachers.

Donasha, an early adopter of technology, had a laptop computer for her own use throughout elementary and high school. As a college student, she now uses a smartphone, a tablet, and a desktop computer, on which she does all her assignments while tracking developments in the medical and educational fields. Based on all of her experiences, Donasha said she is convinced that infusing technology into every curriculum area is unquestionably where teaching is going in the future: "Tablets and smartphones create exciting new opportunities for teaching and learning because kids are able to control parts of their learning environment. Technology offers a bigger invitation to learning than I ever imagined when I started to use it in first grade. There is so much more that I will be able to teach with technology, so I am always learning about how to utilize it with students."

"I like it for my own learning, but I am skeptical about using technology in classrooms," Max countered, explaining that the out-of-date equipment at the school where he is interning is often not working properly and is difficult to schedule for use. "My wariness is not based solely on equipment problems," he explained. "I really think students need to learn how to learn; they should have limited use of computers and videos to figure things out for themselves without

relying on machines. And I do not see the benefit of everyone holding a phone or a tablet all day long instead of reading real books and writing on paper."

Ava admitted that although she is interested in technology as a way to interest students, she feels uncertain about how to use smartphones, tablets, Internet resources, or any of the other emerging technologies as tools for learning. "My concern is that technology changes so rapidly, and the students always know more about all of it than I do," Ava observed. "I realize that there are opportunities for learning using technology, but I wonder how I can learn about them first so I can teach them to students with confidence." Ava anticipated that integrating technology into learning might be a full-time job all by itself and felt nervous about how to do it: "I do not see how I will have time to make technology part of my teaching, unless I can learn more about it first."

Donasha, Max, and Ava are expressing widely held beliefs and uncertainties about the role of technology in schools. Perhaps you have expressed similar views as you think about using technology for learning with students. So have many educators, from new professionals to veteran teachers who have been in the classroom for many years.

To explore the presence of technology in education more fully, we have organized this chapter using a series of five surveys focusing on major issues, developments, and trends in the field of educational technology. There are no right or wrong answers to these surveys. They are intended to challenge your thinking, to encourage you to let new ideas take hold and evolve as you learn more about schools, students, teaching, and technology throughout this book.

Our questions ask you to think in terms of the differences in impact between new and emerging **21st century technologies** and older, more commonplace, and increasingly obsolete educational technologies. Digital technologies for the 21st century feature highly interactive devices and apps that promote active engagement and learning by students.

Handheld devices enable almost anywhere, anytime access to learning and entertainment.

SOURCE: Georgejmclittle/Fotolia

Motivations for Using Technology

2.1 Assess your motivations for becoming a technology-using teacher.

How would you classify your interest in using technology as a teacher? Rate each factor listed in Figure 2.1 as a major factor, a minor factor, or not a factor motivating your decision to use digital technology as a teacher.

You may have selected several major factors for using digital technologies as a teacher. Many teachers would agree. In survey after survey, a majority of educators (between two thirds and three fourths of respondents) say they believe that technology facilitates student learning, provides a positive impact on educational processes, allows for more individual and personalized learning, supports project-based learning, and makes daily teacher tasks like grading and student record-keeping easier and more efficient (Dreambox Learning, 2018; Singleton, et al., 2018; Shifflet & Weilbacher, 2015).

You may have chosen technology as a way to develop engaging learning activities for students. Many teachers do too. More than 9 out of 10 Advanced Placement (AP) and National Writing Project (NWP) teachers report using the Internet to locate lesson plans and teaching materials (Purcell, Heaps, Buchanan, & Friedrich, 2013). Most of these teachers receive online alerts about new developments in their teaching field, while younger professionals are more likely than veteran teachers to engage in online discussions with colleagues and to use web-based tools to edit and share their professional work.

Figure 2.1 What Motivates You to Use Digital Technologies as a Teacher?

Motivating Factor	Major Factor	Minor Factor	Not a Factor
Teach my subject field(s)			
Use time more efficiently			
Plan engaging learning activities			
Support students who are lagging behind or advancing quickly			
Let students use new technologies			
Respond to student interests			
Extend learning beyond the classroom			
Differentiate/personalize learning			
Model technology use for colleagues			
Improve my professional evaluation			
Other			

Enhancing Teaching with Technology

Teachers are also motivated to use technology because it can enhance two major aspects of their daily work in schools and classrooms: 1) instructional practices and 2) administrative/professional activities.

- **Instructional practices** are teaching methods used when interacting directly with students. Examples include using videoconferencing tools to bring authors and scientists into the classroom; asking students to design videos, podcasts, and images to showcase their knowledge; using polling tools to quickly collect student responses and engage a class in discussion about a topic; accessing the web for class discussion; using technology for presentations or simulations; having students use tablets and smartphones as part of group projects; and integrating handheld and wireless devices into academic activities.
- **Administrative/professional activities** include all planning, organizing, and record keeping, as well as data-driven analyses and assessment activities teachers perform to support the direct instruction of students. These behind-the-scenes tasks make instructional practices succeed. Examples include maintaining academic records with grading software, creating a class website to communicate with students and families, conducting correspondence through e-mail, doing research using web resources, and writing reports with word processing software.

Some technologies support both instructional practices and administrative/professional activities. E-mail and collaborative documents can be used to provide formative and summative feedback to students about writing and research projects (instructional practices) and to communicate with families about student learning progress in school (administrative/professional activities). A teacher-created blog or website could display notes from class, describe homework assignments, and present project grading rubrics (instructional practices) while providing a publishing format for students' work, visual records of class field trips, or a calendar of upcoming events (administrative/professional activities).

MyLab Education
Video Example 2.1
In this video, teachers discuss and demonstrate using technology to enhance and expand teaching and learning. How do you imagine integrating digital technologies as learning tools in your future classroom?
https://www.youtube.com/watch?time_continue=30&v=qmLEl4QjQ3w

Most teachers, especially recent college graduates, are familiar with writing on computers, corresponding by e-mail and text messages, and keeping records on spreadsheets and databases. They confidently use technology to handle the preparation and support tasks that make up such a large part of a teacher's workday. Nevertheless, those same teachers have less experience integrating technology seamlessly into the day-to-day activities of classroom learning because innovative uses of new tools were not featured either in their own schooling or in their teacher preparation courses. They are therefore less familiar with using technology to differentiate instruction during class time, assess student learning, or teach 21st century skills.

Part of the challenge and excitement of being a digital-age teacher is developing ways to make new and emerging technologies an integral part of classroom teaching and student learning. In the 21st century, professional educators face the ongoing challenge of creating new instructional patterns, building new technology integration models, and setting new standards of technology-based learning in schools. You can explore more about using technology to design engaging classroom learning experiences for students in Chapter 4.

Motivating and Inspiring Students

Perhaps you indicated in the survey in Figure 2.1 that you would like to use technology as a way to motivate and inspire student learning. If so, you have identified one of the greatest challenges in U.S. education today. Students at every grade level feel detached and alienated from school. Teachers see this disengagement in blank and bored faces, defiant and resentful behavior, and let-me-get-this-done-as-quickly-as-I-can responses to classroom activities or homework assignments.

Multiple studies document a growing problem of **student disengagement**. A national Gallup Poll found that as students progress through school, their level of engagement steadily declines, from nearly 8 in 10 engaged at the elementary school level to only 4 in 10 at the high school level (Busteed, 2013). In another survey, teachers and administrators identified engagement and motivation as the number-one key to academic achievement, but only 4 in 10 said most students at their school are highly engaged academically (Education Week, 2014).

Since 2003, Indiana University's High School Survey of Student Engagement (HSSSE) has been documenting patterns of student boredom and alienation. According to the HSSSE:

- Two thirds of high school students report feeling bored in classes every day.
- Half of all high school students spend 4 hours or less a week doing homework or otherwise preparing for their classes; 20% spend 1 hour or less per week.
- More than half of high school students said that outside of class they never discuss academic material or readings with teachers.
- Half of high school students said they never receive prompt feedback from teachers on assignments.
- Just over half of high school students (57%) said they participate frequently in class discussions or ask questions (52%) of their teachers.
- Just over half of high school students indicated that they put "a great deal of effort" into their schoolwork (Yazzie-Mintz, 2010).

Disaffection from and disengagement with school are factors leading to the significant number of students who leave before high school graduation, a pressing issue facing educators today (Balfanz, Bridgeland, Bruce, & Fox, 2013, 2012). While the dropout rate has declined in recent years, about one in five Black and Hispanic students will not earn a high school diploma or a general education development (GED) equivalent (Fry, 2014). Students who experience "graduation gaps" will be disadvantaged financially over their lifetime; a college graduate will make more than double the annual earnings of someone who has less than a high school education. Meanwhile, society as a whole benefits when students complete postsecondary levels of education—college graduates generally enjoy better health, live longer lives, generate greater taxable

income, and are more likely to vote in elections and volunteer in local communities than are their less-educated peers.

For many students, one key reason for dropping out is that classes are simply not engaging or stimulating enough to keep them in school. Repetitive modes of instruction and teachers who fail to connect academic material from the textbook to real-world issues and problems leave students unmotivated to do assignments and projects. As a result, absence from school becomes more frequent, propelling an alienating spiral of frustration and failure.

To stay engaged with school, students want better teachers, smaller classes, individualized assistance, a school climate fostering achievement, and a strong relationship with at least one adult in the school believing in them and seeing their potential for educational success. Group projects and lessons that incorporate technology are also among the instructional practices that students find most engaging.

Digital Dialog 2.1

Many educators believe that technology enables the active engagement and rapid feedback that students need for maximum learning but do not consistently receive when teachers emphasize whole-class instruction, individual silent reading, and fill-in-the-blank worksheets. As you consider technology's influence on and importance to student learning, comment and connect online about the following questions:

- How are today's media-immersed students different from the way you were as a learner and from students in the past? How are they the same?
- How might technology address persistent patterns of student boredom and alienation from academic learning in schools?
- How might technology help teachers to accommodate the needs of diverse learners?
- How might teachers combine technology-based and non-technology-based resources within classroom lessons to help students demonstrate competency and reflect on their learning?

Approaches to Student Engagement

Actively engaging students in learning is a prime goal of every approach to teaching. Widely used methods for engaging students include:

1. **One-on-one tutoring** engages students by adapting instruction to each learner's individual needs, interests, and knowledge. Adult examples of tutoring include training for high-risk careers, such as piloting airplanes or controlling a nuclear reactor, or preparing for professions in which high artistry is sought, such as master classes for musicians and dancers or personal coaching for athletes, chess players, or actors.
2. **Small group learning** engages students in working on problems collaboratively and cooperatively in ways that produce high-quality explanations and performances among peers. **Learning groups** can vary in size from pairs, trios, and foursomes to larger learning structures.
3. **Inquiry-based learning** engages students in projects that ask them to do authentic and active work by investigating relevant questions in a subject field. Students gain the analytical ability to use information in a variety of ways through researching hypotheses, collecting data, formulating conclusions, and presenting their findings in oral and written formats.
4. **Metacognitive thinking** engages students by encouraging them to examine their own learning through self-explanation and self-evaluation. As students gain the capacity to question and reflect on their own learning, they improve their performance using the concepts and skills they are learning in school.

Imagine a school in which teachers combine instruction with technology to enact active learning, constructivist approaches, and **brain-based education**. What would that look like? One model is High Tech High (HTH) in San Diego, California. Begun in 2000 as a single charter high school, HTH has grown to become a network of high

Table 2.1 Innovative Learning Characteristics of High Tech High

HTH Learning Principle	Key Characteristics
Personalization	Every student has an advisor who oversees long-term goals and short-term performance.
	Every student creates a personal digital portfolio to document the year's learning.
	The school supports full inclusion of students with special needs.
	Networked wireless laptops and tablets are always available for use.
Adult world connection	Students shadow adults in the community.
	Semester-long internships with local businesses and agencies are part of the curriculum.
	Community service learning projects are where independent study projects begin.
	Small-group learning in technology-based labs and project areas is the norm for all students.
Common intellectual mission	No tracking or ability grouping takes place.
	All learning by students is evaluated using performance assessments based on learning rubrics.
	Teachers work in teams.
	Nearly all graduates go to college.

schools, middle schools, and elementary schools serving thousands of public school students. The school's expansive network reflects its remarkable educational successes. Nearly all HTH graduates go to college. HTH also has its own program for preparing new teachers, operated in collaboration with San Diego State University.

HTH's educational philosophy blends new technologies with innovative constructivist approaches to teaching and learning. Responding to the issues of student disengagement and low academic achievement, HTH offers a rigorous, project-based learning curriculum that involves children and adolescents in every aspect of their education. Three principles of learning guide the curriculum and instruction, with technology integrated seamlessly to support the goals of the school (see Table 2.1). The school's founders believe that these learning principles, which are not routinely found in U.S. schools, form the foundation for the kind of education students need to prepare them for 21st century jobs and professions.

Technology is a constant feature of students' everyday educational experiences at HTH in all subjects. Utilizing technology activates the four core approaches of student engagement highlighted earlier: one-on-one tutoring and learning; small-group activities; inquiry-based teaching; and metacognitive and reflective thinking by students. As students use different tools for different purposes, technology becomes the vehicle through which the school and students connect to the community, and the community connects to the school. Furthermore, technology itself serves as a field of study so that students understand how technology impacts schools and society.

MyLab Education **Self-Check 2.1**

Barriers to Technology Use

2.2 Analyze barriers to the use of technology in schools, including digital inequalities, achievement gaps, and online safety and digital privacy issues.

What barriers can potentially impede or block your use of technology as a teacher? Figure 2.2 asks you to rate each factor as either a major barrier, a minor barrier, or not a barrier.

Digital Inequalities and Achievement Gaps

Perhaps you cited a lack of access to up-to-date equipment as a major barrier to using technology regularly with students, as many teachers certainly have. It is true that nearly all public schools have Internet access, and the ratio of students to computers has

Figure 2.2 What Impedes Your Use of Technologies as a Teacher?

Impeding Factor	Major Barrier	Minor Barrier	Not a Barrier
Lack of up-to-date classroom technology			
Inadequate Internet/Wi-Fi connections			
Lack of time during class			
Technology does not fit my teaching style			
Have not received training in how to use digital tools			
Technologies change too rapidly			
Intimidated by technology			
Administrators and other teachers do not support using technology			
Concerns about online safety and digital privacy			
Concerns about student distraction or misuse of technology (e.g., cyberbullying)			
Lack of confidence in troubleshooting if classroom or student technology breaks down			

grown to nearly 1:3. Still, K–12 schools have less technology than is the norm in higher education or corporate America, and the educational technology that is available is replaced or updated less often. Small and rural schools in nearly every state lack the fiber optics needed for high-speed Internet—defined by the Federal Communications Commission as at least 100 kilobits (kbps) per second (Fay, 2017). The result is a **connectivity gap** where schools lack the broadband capacities to provide students with access to today's essential digital technologies for learning.

In recent years, a constant squeeze between the need for expanded technological capabilities and declining educational budgets has forced schools to curtail their technology goals. Although there are schools with multiple computers in every classroom—along with a flat-screen television, high-speed Internet access, a digital projector, and a workstation from which an instructor can control what is happening on student screens—in many schools the technology infrastructure remains locked in the past. In those schools, technology is out of date or in poor condition, software is limited, and software and hardware are often incompatible due to differences in computer memory and operating system requirements. By contrast, teachers with multiple computers in a classroom are more likely to use technology as an integral part of classroom learning. Multiple machines make it easier for a teacher to divide a class into smaller groups, with some students using technology while the rest do other activities.

Access to and use of the latest technologies are not distributed evenly throughout society or schools, creating what educators and social scientists used to call digital divides and now refer to as **digital inequalities**. Digital inequalities happen when non-White, immigrant, urban and rural youngsters from low income areas do not have the same level of access to the latest technologies in school or at home as many of their peers.

Digital inequality produces **technology participation gaps** for minority students and those from low income areas. Even though access to technologies such as cable television, mobile phones, and the Internet has increased across all income levels in our society, participation gaps happen when the latest, most expensive technologies

capable of performing complex tasks and functions are primarily found among affluent and White families and schools in wealthy communities. When students do not have access to the latest technologies, their educational experiences are shortchanged. Researchers have found, for example, that students are more likely to develop interests in science, technology, engineering, and math fields when teachers feature up-to-date digital technology, social media, and student-driven learning as regular components of classroom learning (Project Tomorrow, 2012b).

Digital Dialog 2.2

Many students from low-income and culturally diverse families lack access to the latest, most powerful technologies outside of school. Even when schools have new technologies, some students use tools for inquiry-based investigations, experiments, and research projects while other students are confined mostly to online worksheets with drill and practice exercises. As you think about how you will use technology to reduce digital participation gaps, connect and comment online about the following questions:

- In what ways can integrating technology into classroom instruction and student learning reduce digital participation gaps for students?
- How might you organize classroom instruction to ensure that all students have substantive learning experiences combined with formative and summative assessments?
- Do you see Bring Your Own Device/Technology (BYOD/T) programs as a solution to or a continuation of digital divides, digital inequalities, and digital participation gaps?

Technology access for students exists along a wide spectrum of experiences known as a **digital continuum**. Because far fewer low-income households have the latest technologies or high-speed Internet, students in those households do not have the same media literacy or learning experiences as their more affluent peers. Lack of technology access contributes to academic **achievement gaps**, a term that refers to disparities that result when African American, Asian and Pacific Islander, Hispanic, and Native American students do not succeed academically at the same academic levels as white students; the term can also be applied to differences in educational results between boys and girls, students from higher- and lower-income families, native English speakers and students learning English as a new language, and nondisabled students and students with special educational needs. You can explore more about using technology to address digital inequalities and participation gaps in Chapter 5.

Schedules, Skills, and Supports

For many teachers, and perhaps for you in your responses to the questions in Figure 2.2, a combination of demanding teaching schedules, lack of opportunities to learn about using technology for teaching, inadequate administrative support, and one's personal attitudes act as barriers to the integration of technology into classroom learning. These factors impact:

- ***Teaching schedules.*** Teachers with long block schedules (class periods that last for 90 to 120 minutes) are more likely to use technology than teachers with shorter classes. Longer class periods mean teachers have more time to include digital tools as part of daily instruction. Many schools, however, schedule class periods of less than an hour, and the time needed to get students from the classroom to a computer lab or library and back again makes it difficult to create technology-infused activities. Plus, facing a mandate to teach and review large amounts of curricular material in preparation for state and national education exams, many teachers feel they do not have time to integrate technology into teaching. Teachers teaching fewer curriculum topics were twice as likely to have students using computers in class on a regular basis.
- ***Technology skills.*** Teachers who are technologically skilled integrate technology into classes more frequently than do teachers with fewer technological skills. However, most teachers feel they do not have sufficient technical assistance and

support for using equipment and software in the classroom. Teachers familiar with multimedia tools, presentation software, and interactive web materials tend to be active technology-using educators.

- ***Organizational support.*** Teachers find it more difficult to make technology part of their teaching in schools in which principals do not advocate for technology integration or in which there is no schoolwide emphasis on technology use. Administrators generally set the tone and direction in a school, and teachers find it easier to integrate technology when the principal supports that effort. Professional development for teachers has not kept pace with the changes in technology tools and systems, and educators in low-income schools receive less training than their colleagues in more affluent districts.
- ***Personal beliefs.*** Teachers need a strongly positive belief in the educational potential of technology in order to spend the time needed to learn new tools to motivate and energize students. Not every teacher has that belief. Some teachers are reluctant to use technology due to worry about excessive screen time for students; others are concerned that students might misuse technology (such as through cyberbullying); still others think technology leads children to become distracted and overly sedentary learners. But even teachers with positive attitudes about technology's usefulness struggle to use it in ways that promote student-centered learning. They experience a disconnect between beliefs and practices in which external factors like lack of access or inadequate professional development override their desire to use more technology regularly in the classroom.

As a teacher, you may encounter one or perhaps multiple obstacles to technology use in your school, and while there are no instant solutions, finding ways around the barriers is central to the job of a teacher. Most educators work in organizations that are underfunded and under-resourced. For years, teachers have compensated by working long hours, spending their own money on materials and supplies, collaborating in informal networks, taking extra courses and workshops, writing grants, and lobbying policy makers for change. Responding to barriers to technology use will require all of these strategies and continuous evaluation of how to integrate technology's potential power for student learning into teaching practices.

Critics of Technology in Schools

Thinking about possible barriers to technology use by teachers, you may have concluded that computers and other digital technologies have not yet generated—and perhaps will never produce—substantive changes in how teaching and learning happens in K–12 schools. Technology critics, notably Stanford University historian Larry Cuban, have raised similar points. Cuban (2018, 2013, 2009, 2003) has argued that computers have been "oversold and underused," with their use featuring mainly:

- Drill-and-practice worksheets but not exploratory learning using software and interactive web materials
- Word processing for publishing but not for writing or other forms of creative self-expression by students
- Accessing the Internet as an encyclopedia of information but not as a tool for learning how to do thoughtful research and critical analysis of online materials
- Smartphones, digital cameras, interactive websites, and handheld or wireless devices barely used as learning tools.

In his most recent book, a study of 41 technology-enriched classrooms in six California Silicon Valley school districts, Cuban (2018, p. 2) found "only occasional instances" of teachers integrating laptops and tablets to create more student-centered classrooms and "scattered cases" of schools using technology to substantively alter how teachers teach and students learn—developments he found "puzzling in their isolation from mainstream practices."

Cuban is hardly alone in expressing concerns about technology's impact on students. Noting the increasing use of screen technologies—television, videos, phones,

and tablets—by babies, toddlers, and preschoolers, the Campaign for a Commercial-Free Childhood (CCFC) found few learning benefits and multiple potential risks from increased technology use (CCFC, 2012). The CCFC found evidence of diminished creativity, aggressive behavior, desensitization to violence, and diminished capacity for self-control among preschoolers who were heavy technology consumers.

Other critics worry that children's critical thinking and choice making are being subverted by online commercial marketing that encourages children and families to buy the latest consumer culture items. Many educators recommend that families set screen time limits for children while creating more opportunities for creative play and time to engage in conversations and interactions with adults. Some commentators urge parents to insist that children avoid video games, despite the fact that there is no evidence linking video games to aggressive or violent behavior among youth. In fact, it is adults, not children, who play video games the most.

Some commentators believe that extensive exposure to technology negatively affects users' intellectual development—rewiring brains and making children, adolescents, and adults more demanding of instant results and less able to sustain concentration on complex intellectual tasks (Rosen, 2012, 2010). Nicholas Carr, author of the best-selling book *The Shallows: What the Internet Is Doing to Our Brains,* described his experience before and after the Internet as: "Once I was a scuba diver in the sea of words. Now I zip along the surface like a guy on a Jet Ski" (2011, p. 7). Carr (2015) believes that technology reroutes neural pathways in ways that block thoughtful reflection and deep learning. Yet every new experience—digital, interpersonal, personal—rewires the brain in ways that expand a person's knowledge and capacity for action. More research will be needed to determine just how technology is restructuring how people think and act.

From a different perspective, researchers suggest that teachers and parents should focus more on how children use devices, not solely on how much time they spend with them (Oreo, 2019; Canadian Paediatric Society, 2017). These researchers emphasize the importance of **active screen time** where, rather than passively receiving information from screens (e.g., watching videos or scrolling through social media posts), youngsters are physically or cognitively involved by solving puzzles, thus expending energy and expressing creative ideas. Adults should "mitigate"—not just "minimize"—screen media by watching videos with children, actively curating what programs children are using, and ensuring that youngsters combine screen viewing with active and creative play (Domoff, et al., 2017). These efforts will help children and adolescents to maintain a healthy "digital diet" in which they utilize websites and apps that teach as well as entertain, limit media multitasking when studying, and receive technology guidance and role modeling from parents and teachers.

As a teacher, you will hear competing perspectives about the value of digital tools, and you will need to carefully consider what they mean to your use of technology. Your decisions about technology use will stretch beyond the classroom into the lives of students and families in the community where you are teaching, making your choices important ones for years to come. The book *Plugged In: How Media Attract and Affect Youth* (Valkenberg & Piotrowski, 2017) provides a thoughtful review of evidence about technology's potentials and drawbacks as a learning medium for young students.

Maintaining Online Safety and Digital Privacy

In 2018, the political consulting firm Cambridge Analytica was found to have engaged in mining the data of as many as 87 million Facebook users, vaulting concerns about safety, privacy, and third-party access to personal information to the forefront of public opinion. Facebook subsequently banned the firm from the site while promising to implement new policies to protect the personal information of users. Less well publicized at the time was research by a team of computer scientists and educators who found that some 5,855 of the most popular free third-party apps for children on Android devices were improperly collecting user data (Reyes, et al., 2018). Nearly three in four (73%) of the apps transmitted sensitive data over the Internet; 40% shared information insecurely; and 19% provided private information to third-party services

that were not supposed to be involved with apps for children. All in all, more than half of apps appeared to be in violation of Children's Online Privacy Protection Act (COPPA) regulations.

A definition of terms is important to understanding app/website safety and privacy issues. **COPPA** is a federal law that went in effect in 2000 and was updated in 2013 and 2017. COPPA is designed to protect children under age 13 by setting rules that all Internet-connected companies and services are supposed to follow. In theory, the law protects children's identifying information (including name, address, Social Security number, phone number, username, IP addresses, location data, and more).

In practice, COPPA's protections are far from complete. For example, social media sites like Facebook and YouTube are not required to follow COPPA guidelines since they are meant to be used by individuals age 13 and older. Plus, companies can apply to the Federal Trade Commission for "safe harbor" status that certifies they are in compliance with COPPA guidelines. But researchers found that safe-harbor apps were not as safe as claimed—237 apps transmitted personal information to advertisers even though this was prohibited by the terms of service of apps for children (Reyes, et al., 2018).

In addition, in their eagerness to sell products, online companies are not always vigilant in how user data is collected or shared. Many online games specifically marketed to children use a business model called "freemium" in which the game is free, but advertisements and product linkages are embedded within the program. This encourages users to make in-game or in-app purchases to earn more points and rewards. Meanwhile, the games collect data on users that are sold to third-party vendors.

Third-party apps are software applications developed by someone other than the maker of a technology device. Almost everyone has lots of applications on their computer, smartphone, or tablet that were not made by Apple or Android device manufacturers. Third-party apps have access to your data; for example, anytime you log in to a tool using Gmail, the app can access some or all of your Google data. Once given access to your device, third-party apps have it forever—unless you revoke it, a process users should follow for any web services they no longer wish to use. Go to Google Search Permissions to see all the third-party apps you've given permission to via Google.

Granting access to information can present serious problems. Fordham University School of Law researchers revealed the presence of an extensive and under-regulated market for selling the personal data of student computer and smartphone users (Russell, et al., 2018). Noting that there is no federal privacy law governing student data brokers, the researchers found that personal information was being related to student ethnicity, income, lifestyle, and other criteria. One company, noted the research team, had mailing addresses for over 5 million high school students available for sale for commercial purposes (Russell, et al., 2018, p. 2).

Given privacy concerns, educators and parents wonder how children can safely use websites and apps for educational purposes. There are steps that teachers and parents can take to minimize risks to children when they are using websites and apps.

1. Engage in conversations with children about issues of apps, privacy, and online behavior. Children and adolescents will respond favorably to honest talk from adults who give them positive strategies for how to use online materials safely.
2. Utilize the parental software controls available on most computers, smartphones, and tablets to block sites, impose screen time limits, and monitor online activity. Web browsers like Mozilla Firefox, Google Chrome, and Apple Safari also have functions for controlling the content that children can access. Also disable the automatic installation of apps from third-party vendors so you can select materials on a case-by-case basis.
3. Install kid-friendly browsers that provide protected environments for child users, but note that many of these may be too limiting for older youngsters who require access to a wider range of content on the web to complete school assignments.
4. Download apps only from official app stores (Google Play and Apple App Store), where efforts are made to filter out harmful software.
5. Read reviews and ratings from consumer and educational groups like Common Sense Media to locate safe, high-quality educational materials.