INTEGRATING EDUCATIONAL TECHNOLOGY INTO TEACHING

TRANSFORMING LEARNING ACROSS DISCIPLINES

NINTH EDITION

JOAN E. HUGHES | M.D. ROBLYER

Integrating Educational Technology into Teaching:

Transforming Learning Across Disciplines

9th Edition

Joan E. Hughes
The University of Texas at Austin

M.D. Roblyer
Retired

Pearson

Content Development: Jeffery Johnston
Content Management: Rebecca Fox-Gieg
Content Production: Yagnesh Jani
Product Management: Drew Bennett
Product Marketing: Krista Clark
Rights and Permissions: Jenell Forschler

Please contact https://support.pearson.com/getsupport/s/ with any queries on this content

Cover Image by Lisegagne/E+/Getty Image.

Library of Congress Cataloging-in-Publication Data

Names: Hughes, Joan E., author. | Roblyer, M. D. author.
Title: Integrating educational technology into teaching : transforming learning across disciplines / Joan E. Hughes, M.D. Roblyer.
Description: 9th edition. | Hoboken, NJ : Pearson, 2023. | Includes bibliographical references and index.
Identifiers: LCCN 2021062829 | ISBN 9780137544677 (paperback)
Subjects: LCSH: Educational technology--United States. | Computer-assisted instruction--United States. | Curriculum planning--United States.
Classification: LCC LB1028.3 .R595 2023 | DDC 371.330973--dc23
LC record available at https://lccn.loc.gov/2021062829

ScoutAutomatedPrintCode

Rental:
ISBN-10: 0137544677
ISBN-13: 9780137544677

Pearson's Commitment to Diversity, Equity, and Inclusion

Pearson is dedicated to creating bias-free content that reflects the diversity, depth, and breadth of all learners' lived experiences.

We embrace the many dimensions of diversity, including but not limited to race, ethnicity, gender, sex, sexual orientation, socioeconomic status, ability, age, and religious or political beliefs.

Education is a powerful force for equity and change in our world. It has the potential to deliver opportunities that improve lives and enable economic mobility. As we work with authors to create content for every product and service, we acknowledge our responsibility to demonstrate inclusivity and incorporate diverse scholarship so that everyone can achieve their potential through learning. As the world's leading learning company, we have a duty to help drive change and live up to our purpose to help more people create a better life for themselves and to create a better world.

Our ambition is to purposefully contribute to a world where:

- Everyone has an equitable and lifelong opportunity to succeed through learning.
- Our educational content accurately reflects the histories and lived experiences of the learners we serve.
- Our educational products and services are inclusive and represent the rich diversity of learners.
- Our educational content prompts deeper discussions with students and motivates them to expand their own learning (and worldview).

Accessibility

We are also committed to providing products that are fully accessible to all learners. As per Pearson's guidelines for accessible educational Web media, we test and retest the capabilities of our products against the highest standards for every release, following the WCAG guidelines in developing new products for copyright year 2022 and beyond.

You can learn more about Pearson's commitment to accessibility at **https://www.pearson.com/us/accessibility.html**

Contact Us

While we work hard to present unbiased, fully accessible content, we want to hear from you about any concerns or needs with this Pearson product so that we can investigate and address them.

Please contact us with concerns about any potential bias at **https://www.pearson.com/report-bias.html**

For accessibility-related issues, such as using assistive technology with Pearson products, alternative text requests, or accessibility documentation, email the Pearson Disability Support team at **disability.support@pearson.com**

Pearson

For all educators, including those in my family: my mother Judith Hughes (retired middle school teacher and vice-principal); siblings Deidre Hughes (community college professor), Thomas Hughes (high school teacher), Eileen Hughes (former high school teacher), and brother-in-law Craig Holliday (high school teacher); niece Margaret Hughes (paraprofessional); and parents-in-law Diane Stehr (retired all-grades special education teacher) and Paul Klancher (retired high school teacher).

—JEH

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

—MDR

About the Authors

Joan E. Hughes has been a technology-using educator and contributor to the educational technology field for nearly 30 years and has authored or coauthored more than 100 publications, including books, book chapters, journal articles, proceedings, and research and practitioner conference papers worldwide.

After earning a bachelor of arts degree in English from Pomona College, she began working in the educational technology field as an elementary and middle school computer teacher in the Silicon Valley area of California in the early 1990s. As a classroom teacher, she presented often at the CUE Conference (known then as Computer Using Educators) and coauthored (with Terry Maxwell) her first book, *The CompuResource Book*, a collection of technology-supported lessons. Later, she pursued her doctorate in educational psychology with emphasis on cognition and technology at Michigan State University where she taught courses for preservice teachers in Michigan and inservice teachers internationally in Korea, Japan, Thailand, and England. Her earliest doctoral research developed the concept of technological pedagogical content knowledge, a theory generated from case studies of English teachers' learning and use of technologies in schools. This theory has been adapted and adopted widely.

Currently, Dr. Hughes is Associate Professor of Learning Technologies at The University of Texas at Austin where she conducts research and instructs on how teachers and K–12 students use technologies in and outside the classroom for subject-area learning; how school leaders support classroom technology integration; and how educators are technological innovators and valuable contributors in the edtech ecosystem. She serves on editorial and review boards for several teaching and technology journals and has contributed to leadership of technology-related special interest groups. She is highly supportive of her students' educational objectives and has guided 56 doctoral and 56 master of arts and master of education degree students to complete dissertations, theses, or reports.

She is married to Lee Klancher, a writer, photographer, and publisher (Octane Press). They spend time exercising their dog (currently, an adopted German shorthaired pointer named Red Cloud), running, biking, cooking, eating, and camping in Austin and around the world.

M. D. Roblyer was a technology-using professor and contributor to the field of educational technology for 35 years. She authored or coauthored hundreds of books, monographs, articles, columns, and papers on educational technology research and practice. Her other books for Pearson Education include *Starting Out on the Internet: A Learning Journey for Teachers*; *Technology Tools for Teachers: A Microsoft Office Tutorial* (with Steven C. Mills); *Educational Technology in Action: Problem-Based Exercises for Technology Integration*; and the most recent text, *Introduction to Instructional Design for Traditional, Online, and Blended Environments* (2015).

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

Dr. Roblyer retired in 2015 after having served as a teacher, professor, graduate student mentor, doctoral student dissertation chair and committee member, and leader in shaping educational technology's changing role since 1969. She lives in Chattanooga, Tennessee, and is completing work on a memoir of her early life. She is married to fellow Florida State alumnus Dr. William R. Wiencke and a proud mother of daughter Paige Roblyer Wiencke.

Preface

About This Book

During a time when nearly everything else is changing rapidly and radically, the mission of this textbook has remained steady and consistent: to reflect the burgeoning, evolving role of technology in education. The book's 25-year history has always documented new and significant transitions in the role of technology in education, and the ninth edition continues that work. This edition continues its commitment to developing teachers as technology leaders, prioritizing transformative technology integration in the classroom, emphasizing unique affordances of technology for 12 content-area disciplines, and positioning all practices in relation to contemporary educational research perspectives. This edition also launches keen attention to the current issues of digital inequity in our society that influence children's educational success.

The text includes four sections that position the reader as a teacher learner and leader of transformative technology integration. The first section provides a definition of educational technology and the historical underpinnings of the field that inform our current practices, the learning theories that shape pedagogy, and a technology integration planning model that guides teachers to design technology-supported pedagogy that is responsive to instructional, curricular, or learning challenges. It provides the foundation for teachers to problem-solve, learn and lead through online networks, build a compelling online professional identity, and employ a professional rationale for using technology in all decision making. The second and third sections introduce the technological resources that support teaching and learning. The second section focuses on the digital content teachers and students use for learning. It reviews the content available on the web as well as within instructional software. These chapters also provide helpful evaluation criteria for use in reviewing and selecting digital content for adoption. The third section presents the digital resources that facilitate critical thinking, design, analysis, creation, communication, and collaboration. Ultimately, educators use all these digital resources to build blended or online learning lessons or curricula. The fourth section continues this book's commitment to technology integration in content-area disciplines with a chapter specific to the following content areas: special education; English and language arts (ELA); second and foreign languages; science, technology, engineering, and mathematics (STEM); social studies; music and art; and physical and health education. We go well beyond describing the technical features and capabilities of 21st-century digital resources to focus steadfastly on the research-based teaching and learning strategies that these resources can support in content areas.

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

1. **Integrating educational technology should be based in learning theory, teaching practice, and curriculum.** There is no shortage of innovative ideas in the field of educational technology; new and interesting methods come forth about as often as new and improved gadgets. Those who would build on the knowledge of the past should know why they do what they do as well as how to do it. Thus, various technology-based integration strategies are linked to well-researched theories of learning, and we have illustrated them with examples of successful practices based on these theories.
2. **A combination of technological, pedagogical, and content knowledge optimizes technology integration.** This textbook maintains that teachers not only need to

know the content they are teaching and good pedagogical strategies for connecting students with content, but also must recognize how to integrate technology into pedagogy to achieve the greatest impact on desired outcomes. In other words, teachers need what the field now refers to as technological pedagogical content knowledge, TPCK, or TPACK (described in Chapter 3).

3. **Uses of technology should match specific teaching and learning needs.** Some technology resources have the power to improve teaching and learning. Therefore, each resource should be examined for its unique qualities and potential benefits for teachers and students. Teachers should not use a tool simply because it is new and available; each integration strategy should be matched to a recognized need. Teachers should absolutely experiment as long as they begin with a problem of practice and carefully evaluate the outcome. The Technology Integration Planning model introduced in Chapter 3 guides teachers in this process.
4. **Old integration strategies are not necessarily bad; new strategies are not necessarily good.** As technologies change and evolve at lightning speed, there is a tendency to throw out older teaching methods with older machines. Sometimes this is a good idea; sometimes it would be a loss. Each of the integration strategies and technology resources recommended in this book are based on methods with proven usefulness to teachers and students toward solving learning needs rather than its age.

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

What's New in the Ninth Edition

Best known for its technology integration strategies grounded in strong research, the ninth edition of *Integrating Educational Technology into Teaching: Transforming Learning Across Disciplines* offers a total technology integration framework across all content areas. It also gives teachers practice with technology resources as they learn how to incorporate technology to support curriculum in ways that transform instruction and learning. And as usual, this edition includes additions that reflect changes in the field of educational technology.

- **A NEW Focus on Digital Equity.** Each chapter includes a key feature highlighting a digital equity issue relevant to the chapter's thematic content, such as definitions of digital equity and justice; ways to use technology for equitable learning practices; an overview of the universal design for learning framework; current statistics on Internet access in students' homes; ways to move from inequitable, passive digital practices to humanized and empowered digital learning in classrooms; and examinations of the representation of minoritized children (e.g., girls, students of color, students with learning needs, and students of lower socioeconomic means) in digital innovation learning contexts like makerspaces and in online learning opportunities. We also provide practical suggestions for teachers to take action to examine each issue in locally relevant ways.
- **A NEW Commitment to Social Constructivism.** In Chapter 2, the text provides an exhaustive review of both directed and social constructivist theories and beliefs and describes how these contribute to differing pedagogical strategies with technology because both approaches exist within K–12 schools. Yet, throughout the text, the authors predominantly exemplify technological pedagogy in alignment with social constructivism because these approaches situate children in agentic,

active, and hands-on learning with technologies. All chapters open with a richly described *Technology Integration in Action* scenario and include several *Technology Integration Example* lessons throughout, all aligned with the chapter's thematic content and crafted to help teachers discern the value of social constructivism in digital learning.

- **A NEW Acknowledgment on Technology's Role in Local and Global Disasters.** Chapters highlight how technology can exacerbate or ameliorate educational challenges during global disasters, such as our current COVID-19 pandemic, and during local disasters, such as forest fires, hurricanes, tornados, floods, and earthquakes. Examples describe how the pandemic illuminated the entrenched digital inequities in our society, such as lower access to broadband Internet and home computing devices by many families in our communities, that decreased their access to education when separated from physical school buildings. On the other hand, access to digital technologies, high-speed Internet, and high-quality online learning experiences help maintain children's access to education during such physical separations. The overall goal of the text is to prepare teachers to be pedagogically ready to plan and teach in blended and fully online modalities, while also anticipating and advocating for students who may experience issues with digital access.
- **NEW Research Perspectives.** Every topic in every single chapter reflects the newest educational research perspectives since 2016, when the last edition of this text was published. We conduct comprehensive reviews of the research literature to ensure that our practical recommendations for teachers are research based. This research directly informs the chapters' sections that review the benefits, challenges, integration strategies, and selection or evaluation criteria related to the myriad of digital resources included in the text. While the idea of "research" may seem distant to classroom practitioners, it is important to remember that all educational research occurs in classrooms in collaboration with children and their parents and teachers and school leaders. Research allows us to understand educational practice and perspectives in collective and organized ways so teachers can glean insights from those who have come before them.
- **NEW Examples and Videos.** This text reflects real educational technology practices in real schools. Chapters include numerous new technology integration ideas, lessons, perspectives, and videos exemplifying the reviewed digital resources and pedagogical approaches. These depicted technology integration practices are sourced from practitioner magazines, conferences (such as ISTE), teacher blogs and tweets, and from the research literature. New videos are organized to match the chapter's thematic content and are sourced from real classrooms and from YouTube videos published by nonprofit organizations, schools and teachers, and educational technology companies.

Key Content Updates by Chapter

- **Chapter 1.** Updated the definition of *educational technology* and the *integrating educational technology* framework that aligns with the Technology Integration Planning (TIP) model introduced in Chapter 3 and used throughout the book; added the *digital justice* era into the depiction of educational technology across time; updated the emerging digital resources and trends in blended and online learning, games and gamification, personalized learning, maker and DIY, computational thinking, and immersive learning; added information about digital privacy, health and well-being, digital identity, and digital equity and justice in the conditions that influence the environment for using technology.

- **Chapter 2.** Reorganized the learning outcomes to align with the first triangle of the *integrating educational technology* framework that focuses on educational processes—learning theories, pedagogy, and curriculum/content—as introduced in Chapter 1; removed multiple intelligences theory; added a description of critical pedagogy and its implications for practice and for technology integration; added descriptions of each of the most current ISTE Standards for Students (2016); and added new Technology Integration Examples.
- **Chapter 3.** Reorganized the first learning outcome to align with the second triangle of the *integrating educational technology* framework that focuses on technology resources–technology tools, technology expertise, and technology support–as introduced in Chapter 1; added an author-designed survey for teachers to gauge their expertise based on the most current ISTE Standards for Educators (2017); updated sections on how teachers can become and the value of being connected learners through online networks; updated the TIP model (previously in Chapter 2), which guides teachers in planning technology-integrated lessons from an asset-based orientation and includes the RAT assessment model for determining relative advantage of technology in lessons.
- **Chapter 4** (previously Chapter 6). Relocated as the first chapter of Part 2, Digital Content for Learning; added lateral reading as a strategy for online information literacy; added a digital well-being section to safety and security; added digital justice issues related to use of online proctoring software; updated all technological resources to the most current.
- **Chapter 5.** Reordered the instructional software by its predominant alignment with directed (learning outcome 5.2) or with social constructivist learning theories (learning outcome 5.3); added a new Technology Integration in Action scenario at chapter opening; updated all technological resources to the most current; described perspectives that frame some instructional software as deficit-based and dehumanizing; included a comparison table of aspects of humanized and dehumanized personalization built into instructional software; added cautionary information related to use of simulations or games that involve content involving racial and social oppression.
- **Chapter 6** (previously Chapter 4). Relocated as the first chapter of Part 3, Digital Resources for Critical Thinking, Creating, Communicating, and Collaborating in Blended and Online Contexts; reframed the learning outcomes to be about the learning activity (e.g., writing, representing, analyzing) rather than the technological software; added a table summarizing how a design process is involved in the digital learning activities under focus; updated all technological resources to the most current; added new Technology Integration Examples; updated and integrated assessment activities into a data collection, analysis, and assessment section (learning outcome 6.3)
- **Chapter 7.** Updated learning outcomes to focus on the digital activities of communicating, collaborating, and making; added a table summarizing how a design process is involved in the digital learning activities under focus; updated all technological resources to the most current; added new Technology Integration Examples; added parent communication and collaboration strategies; added multifunction workspaces (e.g., Slack, Microsoft Teams); updated information on learning management systems; updated section on digital making, including computer programming, robotics, 3-D modeling and animation, game and app development, virtual world and augmented reality development, and web design and development.
- **Chapter 8.** Added a representation of the key terms used across the continuum of in-person learning to blended and online learning modalities; updated the descriptions of the seven blended learning models; described ways in which low

home access to digital resources impedes access to blended and online learning; updated the online course models; added a section on the varied combinations of in-person, blended, and online learning (sometimes called "hybrid") that schools implemented during the pandemic; added an author-created list of discussion forum content category tags that support student metacognition and rich online discussions; updated all technological resources to the most current.

- **Chapter 9.** Updated the number of students with disabilities currently being served for special education across schools; updated the laws and policies that impact the use of technologies for special education purposes; added a section on the universal design for learning framework and how it can be used to guide design of online learning; acknowledged how the COVID-19 pandemic's reliance on online learning negatively impacted many students with disabilities; added a digital equity and justice issue concerning how technologies can limit accessibility to digital information; updated the *Top Ten Must-Have Special Education Technologies*; updated Twitter hashtags to follow for networked learning; updated all technological resources to the most current.
- **Chapter 10.** Updated the competencies of digitally literate learners; added a digital equity and justice issue concerning income-based online reading achievement gaps; updated all statistics related to print and digital reading patterns; updated the *Top Ten Must-Have Technologies for English and Language Arts*; added new Technology Integration Examples; updated Twitter hashtags to follow for networked learning; updated all technological resources to the most current.
- **Chapter 11.** Clarified terms related to English learners who may already speak multiple languages, thus learning English is not necessarily their *second* language; updated the characteristics and diversity of the English learner population and described four groups of learners; updated the importance of involvement of content-area teachers in students' academic and language development; added a digital equity and justice issue concerning inclusion of parent perspectives from new immigrant families in school- or home-based technological adoptions; updated the *Top Ten Must-Have Technologies for Language Learning*; added a section on online learning; updated Twitter hashtags to follow for networked learning; updated all technological resources to the most current.
- **Chapter 12.** Updated opening section that distinguishes STEM content, context, and tool/application integration instruction; added a digital equity and justice issue concerning inequitable outcomes on a national assessment of eighth-grade students' technology and engineering literacy; updated section on using technology to support NGSS-aligned scientific discovery; updated the *Top Ten Must-Have Technologies for STEM Instruction*; updated approaches to engineering education through makerspaces, programming, robotics, and simulations; updated recommendations for teachers to use mathematical action technologies in alignment with social constructivism; added section on developing students' data literacy; updated Twitter hashtags in science, engineering, and mathematics for teachers to follow; updated all technological resources to the most current.
- **Chapter 13.** Added a new section on the need for and challenge of achieving diversity, equity, and inclusion in social studies; added new lesson resources for helping students assess quality of informational sources; added a digital equity and justice issue concerning how extended reality technology resources, such as virtual and augmented reality experiences, may introduce barriers for students with some disabilities; updated the *Top Ten Must-Have Technologies for Social Studies*; new Technology Integration Examples; new section on online learning in social studies; updated Twitter hashtags for teachers to follow for networked learning; updated all technological resources to the most current.

- **Chapter 14.** Added a digital equity and justice issue concerning the need for greater inclusion of musical and visual art content genres beyond the canons of "fine art" in education; added a section about ethical issues for music educators; updated the *Top Ten Must-Have Technologies for Music and Visual Arts Instruction*; added a new section that situates the impact of technology on the visual arts in education and society; added a new section on design and innovation in visual art education along with a design process for students to pursue projects in the visual arts; added a new section about the need for inclusion of creations by marginalized populations; added a new section on integrating visual art with other disciplines; added new Technology Integration Examples; updated section on artistic and design creation; added section on teaching visual arts online; updated Twitter hashtags in music and visual arts for teachers to follow for networked learning; updated all technological resources to the most current.
- **Chapter 15.** Updated physical activity, diet, and obesity trends to reflect the most recent data; updated section on national standards and barriers to quality health and physical education programs; Added a digital equity and justice issue concerning hunger and food insecurity, with practical suggestions for using digital tools for community walks and equity audits of the food landscape so teachers can best advocate for learners; updated the *Top Ten Must-Have Technologies for Health and Physical Education*; reorganized integration strategies into sections about improving instructional effectiveness, maximizing practice opportunities, providing feedback and assessment, monitoring physical activity and nutrition, accommodating students with special needs, helping students find valid online information, influencing health behaviors beyond school, and providing online modalities for health and physical education; updated Twitter hashtags for teachers to follow for networked learning; updated all technological resources to the most current.

Pedagogical Features of This Text

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

Introduces Teachers to Technology Integration

TECHNOLOGY INTEGRATION IN ACTION:

Producing Authentic Historical Interviews

GRADE LEVEL: 8–12

CONTENT AREA/TOPIC: U.S. History

LENGTH OF TIME: Two weeks

Phase 1 Lead from Enduring Problems of Practice

Step 1: Identify problems of practice (POPs)

Like many social studies teachers, Mr. Engle sought to create learning experiences where students could make meaningful connections between the past and present. In past years, students had read accounts of the Holocaust and Rwandan genocides, but he was not sure that his students really understood the experiences of people during these

◀ **Technology Integration in Action** examples located at the beginning of each chapter are school-based scenarios that match the chapter's thematic content. Beginning in Chapter 4 and continuing through Chapter 15, each Technology Integration in Action opening scenario focuses on a teacher's selection and use of specific technology within a classroom environment to solve a specific problem of practice. Each scenario walks the reader through the steps of the Technology Integration Planning (TIP) Model and lesson RATification using the Replacement, Amplification, and Transformation (RAT) Assessment model introduced at the end of Chapter 3. These classroom-based scenarios are tied specifically to the chapter's learning outcomes.

▶ **Digital Equity and Justice** features highlight a digital equity issue relevant to the chapter's thematic content and provide practical suggestions for teachers to take action to examine each issue in locally relevant ways.

BOX 4.1 **DIGITAL EQUITY AND JUSTICE**

Internet Access

The COVID-19 pandemic blatantly illustrated the breadth of digital inequities in the nation. It is a significant injustice for teachers to assume that all students have access to computers and Internet in their homes and communities. The U.S. Census estimates 82.7% of households have a broadband Internet subscription (U.S. Census, 2019), and Table 4.3 shows a snapshot of Internet availability in 2021 by race and income characteristics. Several trends in the data from the U.S. Census, as shown in the table, are important.

- Some portion (11% or more) of households, across all races, ethnicities, or income levels, do not have Internet *always available*.
- With the exception of census respondents identified as Asian, people of color have less consistent *always available* access to Internet in their households than White respondents.

Table 4.3 Availability of Internet for Educational Purposes in Households with Children in Private or Public Schools (U.S. Census Bureau Household Pulse Survey, Week 24, 2021)

		Always available	Usually available	Sometimes available	Rarely available	Never available
	Total, All (*n* = 50,522,411)	74.8%	17.8%	3.2%	0.9%	0.6%
Race and Ethnicity	Asian alone, not Hispanic	83.9%	12.7%	1.4%	0.1%	0.1%
	White alone, not Hispanic	77.5%	16.5%	2.7%	1.0%	0.3%
	Black alone, not Hispanic	70.6%	16.9%	3.9%	1.0%	2.5%
	Hispanic or Latino (may be of any race)	69.6%	22.2%	3.9%	0.8%	0.3%
	Two or more races + Other races, not Hispanic	67.5%	22.0%	5.9%	1.3%	0.2%
Income	Less than $24,999	64.0%	24.0%	7.2%	2.8%	1.2%
	$25,000–49,999	67.0%	26.6%	4.5%	1.5%	0.2%
	$50,000–99,999	78.2%	18.2%	2.6%	0.5%	0.1%
	$100,000–149,999	83.5%	14.1%	2.1%	0.2%	0.1%
	$150,000 and above	88.2%	8.8%	1.0%	0.7%	1.3%

Table 12.2 Top Ten Must-Have Technologies for STEM Instruction

Technology	Description
Desmos	Desmos is a free online or iPad graphing calculator. Students can save their graphs, equations, tables, and pictures on it. The tool is available in over 20 languages.
EcoLearn	EcoLearn is an educational research group at Harvard that offers a suite of immersive technologies to support learning about the environment (ecoMUVE, ecoMOBILE, ecoXPT, and ecoMOD). These technologies are virtual environments that are appropriate for students in grades 6–12.
GeoGebra	GeoGebra is a dynamic, interactive, online mathematics software package for STEM learning that is appropriate for upper elementary through high school students. It includes a dynamic 2-D and 3-D geometry environment with a spreadsheet, a computer algebra system including statistics and calculus tools, and scripting.
Notability	Notability is an iOS/OSX app that allows students to take multimedia notes and perform PDF annotations. This application is wonderful for notebooking in STEM. Notability enables students to take notes with handwriting by their finger or a stylus, type notes, highlight text, import PDFs and other images, audio-record notes, link audio recordings to written notes, share documents, and sync notes to Dropbox, Google Drive, or Box.
PhET	Free virtual simulations for mathematics and science content. These simulations cross a wide variety of topics and work on many platforms.
Scratch 2/Scratch Jr.	Scratch 2 (web-based) and Scratch Jr. (iPad or Android app) are tools that allow students of all ages to learn to code. It is a block-based computer programming language that allows students to develop and share interactive stories, animations, and games.
Tinkercad	Tinkercad is a free, 3-D modeling computer-aided design software program appropriate for educators and hobbyists. It allows for translation of designs to be actualized through 3-D printing. It is a fun and fairly intuitive program for students to make their design ideas come to life.
TinkerPlots	TinkerPlots is an interactive data visualization and modeling tool for students in upper elementary grades through high school. It is an appropriate tool for any subject in which data need to be analyzed. It allows students to create colorful visual representations that allow for patterns in the data to emerge.
Vernier interfaces and probeware	Vernier interface and probeware sets provide students active hands-on science, engineering, and mathematics learning through a combination of multiple probeware sensors and data loggers for gathering real-time data for experiments and graphical analysis. These are appropriate for students in upper elementary grades through high school.
WISE: Web-based Inquiry Science Environment	WISE is a digital learning platform that allows students to observe, analyze, conduct experiments, and reflect on their learning as they work within WISE projects. Projects are mostly written for middle school students, but a few of them are appropriate for high school. WISE includes the student learning environment as well as many course-management tools and assessments from which teachers can choose.

◀ **Top Ten Must-Have Technologies** identify and describe the most recent and helpful educational technologies in the disciplinary content areas in Chapters 9–15, as selected by the disciplinary expert authors.

Helps Teachers Plan for Effective Technology Integration

▶ **Technology Integration Examples** (TIEs) in Chapters 2–15 offer numerous technology lesson ideas that reflect the thematic content in each chapter and can inspire lesson planning across the curriculum. Each lesson suggestion is correlated to the ISTE National Educational Technology Standards for Students (2016) and Common Core State Standards, as applicable.

TECHNOLOGY INTEGRATION **Example 2.1**

TITLE: Digital Literacies for Social Justice Inquirers

CONTENT AREA/TOPIC: Literacy

GRADE LEVELS: Middle school

ISTE STANDARDS • S: Standard 1—Empowered Learner; Standard 2—Digital Citizen; Standard 3—Knowledge Constructor; Standard 6—Creative Communicator; Standard 7—Global Collaborator

CCSS: CCSS.ELA-LITERACY.RH.6-8.1, CSS.ELA-LITERACY.RH.6-8.4, CCSS.ELA-LITERACY.RH.6-8.8

DESCRIPTION: Students can become a community of social justice inquirers who seek to learn about local issues and advocate for social change. These New York City students began by identifying important topics and chose to investigate their community's poverty and crime. Students brainstormed their own knowledge and their questions about the topic using Answer Garden, a collaborative brainstorming tool. They watched a film documentary that revealed the social construction of class in their neighborhood and other wealthier neighborhoods, after which they explored and observed their neighborhoods, capturing and sharing digital photographs and notes within a collaborative Google Doc. They used curated information on Flipboard to further develop their background knowledge. Then, students began expressing their developing knowledge as counter-stories about race, class, and crime by creating memes using Meme Generator. In class discussions, they culminated the unit by generating ideas for solution-oriented actions they might take in their community.

SOURCE: Based on Price-Dennis, D., & Carrion, S. (2017). Leveraging digital literacies for equity and social justice. *Language Arts*, *94*(3), 190–195.

CHAPTER 6 SUMMARY

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

1. **Design, Analysis, and Creation**
   - Teachers and students engage in design and transmediation processes when using digital resources to express their ideas, concepts, or knowledge.
2. **Digital Writing and Publishing**
   - Digital writing and publishing activities can be accomplished with word processing and desktop publishing software.
   - Written and artistic expressions can be published online or created in digital stories or books. Integration ideas include content-related creations, such as cookbooks, field guides, or creative writing.
3. **Creating Multimodal Representations**
   - Digital representations help teachers and students display information, including text, images, graphics, symbols, audio, video, and websites to demonstrate concepts or developed knowledge.
   - Teachers use representations to enhance the impact of spoken information, enable multimedia-rich content depictions, make content polished and professional, organize thinking about a topic, and create enduring learning artifacts. Uses include demonstrating content concepts, illustrating problems and solutions, presenting informational summaries, using multimedia assessment, creating tutorials or game-based reviews, and developing interactive lessons.

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

Helps Teachers Practice Technology Integration

Teacher Growth in Technology Integration Strategies for Music

These sections have introduced the issues, challenges, and strategies for integrating technology into music instruction and learning. In the future, teachers can begin developing expanded and strengthened capabilities to understand emerging issues, generate possible solutions, and address technology integration in music education. Review the rubric in Table 14.3, which can guide a teacher's progress in integrating technology in music instruction.

In the mid-2010s, the National Coalition for Core Arts Standards released updated standards for dance, media arts, music, theater, and visual arts. These standards are shaped around fundamental processes of interacting with the arts: creating, performing/presenting/producing, responding, and connecting. The standards in music vary in their usefulness, but it is important to note that, in the 2014 version of the music standards, there is a strand of music technology standards. Music teachers wishing to integrate technology into their teaching may look to this set of standards for high-level guidance.

In addition to resources from this chapter, teachers can become involved in music professional organizations, such as NAfME and TI:ME, both of which offer teaching resources, advocacy ideas, professional development, and collaboration opportunities. The American Mathematical Society is another organization that offers specific resources for connecting mathematics and music. Finally, teachers

◀ **A Teacher Growth Section** located at the end of each discipline-specific chapter (Chapters 9–15) offers strategies for continued teacher learning and leadership in content-specific technology integration. It also includes a rubric that teachers can use to self-assess and direct their growth in technology integration and suggests Twitter hashtags to follow.

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

TECHNOLOGY INTEGRATION WORKSHOP

Apply What You Learned

In this chapter, you learned about teaching and learning with technology in health and PE. Now apply your understanding of these concepts by doing the following activities:

- Reread Mr. Martinez's lesson *Developing an Interest-Based, Personal Physical Activity Plan* at the beginning of this chapter. Pay close attention to Step 3 of the Technology Integration Planning (TIP) model when they identify the technological possibilities for their problem of practice: increasing students' physical activity, optimizing healthy eating, and engaging in the scientific method. Using your knowledge about technology integration strategies for health and PE introduced in this chapter, generate at least one new technological possibility for targeting Mr. Martinez and Ms. Floyd's problem of practice.
- Review how Mr. Martinez and Ms. Floyd RATified the lesson in Step 5 of the TIP model, as represented in Table 15.1. Use the **RAT Matrix** to analyze the role(s) and relative advantage that your new technological possibilities (identified in the preceding step) would play in the lesson. You must reflect on the

- **Apply What You Learned** exercises, which call for students to reread the Technology Integration in Action example that opened the chapter; identify another, different technology resource possibility to solve the problem of practice set within the example; and complete a RAT matrix analysis to determine the new technology resource's potential for changing instruction, learning, and/or curriculum.
- **Technology Integration Lesson Planning: Evaluating Lesson Plans** exercises provide students the opportunity and resources to evaluate a set of technology integration lessons.
- **Technology Integration Lesson Planning: Creating Lesson Plans with the TIP model** activity asks students to create a new technology-supported lesson plan that employs a technology resource introduced in the chapter to solve a problem of practice. Students do so by implementing the TIP model and are encouraged to share their lessons.
- **Technology Lesson Plan Evaluation Checklist and the RAT matrix** introduced in Chapter 3 are used throughout the workshop activities.

Learning Management System (LMS)–Compatible Assessment Bank, and Other Instructor Resources

LMS-Compatible Assessment Bank

With this new edition, all assessment types—quizzes, application exercises, and chapter tests— are included in LMS-compatible banks for the following learning management systems: Blackboard (**9780137544455**), Canvas (**9780137544486**), D2L (**9780137544523**), and Moodle (**9780137544530**). These packaged files allow maximum flexibility to instructors when it comes to importing, assigning, and grading. Assessment types include:

- **Learning Outcome Quizzes** Each chapter learning outcome is the focus of a *Learning Outcome Quiz* that is available for instructors to assign through their LMS. Learning outcomes identify chapter content that is most important for learners and serve as the organizational framework for each chapter.

The higher-order, multiple-choice questions in each quiz will measure your understanding of chapter content, guide the expectations for your learning, and inform the accountability and the applications of your new knowledge. Each multiple-choice question includes feedback for the correct answer and for each distractor to help guide students' learning.

- **Application Exercises** Each chapter provides opportunities to apply what you have learned through *Application Exercises*. These exercises are usually short-answer format and are based on the Technology Integration in Action opening scenarios at the beginning of Chapters 4–15. The exercises draw students to consider how the teacher in the opening scenario engages with the Technology Integration Planning model to design a technology-integrated lesson. Students engage with the TIP steps to identify the problem of practice, technology possibilities, integration strategy, technology-related assets, and the RATification (relative advantage) within the lesson. After deep analysis of that lesson, students are called upon to use the broader content from the chapter to propose alternative technological possibilities to solve the problem of practice and how they would RATify the lesson. Finally, students will use resources from the text to evaluate other lesson plans related to the content of the chapter to determine if they would or would not use them through the RATification process to determine relative advantage. A model response written by experts is provided to help guide learning.
- **Chapter Tests** Suggested test items are provided for each chapter and include questions in multiple-choice and short-answer/essay formats.

Instructor's Manual (9780137544431)

The Instructor's Manual is provided as a Word document and includes resources to assist professors in planning their course. These resources consist of chapter overview concepts to emphasize, chapter activities, group activities, and assessment activities.

PowerPoint® Slides (9780137544554)

PowerPoint slides are provided for each chapter and highlight key concepts and summarize the content of the text to make it more meaningful for students.
Note: All instructor resources—LMS-compatible assessment bank, instructor's manual, and PowerPoint slides—are available for download at www.pearsonhighered.com. Use one of the following methods:

- From the main page, use the search function to look up the lead author (i.e., Hughes), or the title (i.e., Integrating Educational Technology into Teaching: Transforming Learning Across Disciplines). Select the desired search result, then access the "Resources" tab to view and download all available resources.
- From the main page, use the search function to look up the ISBN (provided above) of the specific instructor resource you would like to download. When the product page loads, access the "Downloadable Resources" tab.

Acknowledgments

Both the goal and challenge of this book have been to provide the reader with the most up-to-date foundations, theory, research, and practices in educational technology across the disciplines. We believe this goal has been achieved. As in any project, realizing this goal would not have been possible without the assistance of numerous individuals who helped sharpen the focus of this edition. These individuals include the reviewers for

this edition: Mark Viner, Eastern New Mexico University; Mark Ortwein, University of Mississippi; J. Michael Blocher, Northern Arizona University; Eileen Ariza, Florida Atlantic University; Dennis Beck, University of Arkansas; Chad Seals, The University of Southern Mississippi; and Chih-Hsiung Tu, Northern Arizona University.

The vibrancy of this new edition is partly due to the contributors for the current edition, who all engage in researching and using the latest technology-supported teaching and learning approaches in their discipline areas. The contributors include the following:

Chapter 9
Teaching and Learning with Technology in Special Education

Min Wook Ok, Assistant Professor of Special Education
Daegu University, South Korea
College of Education

Chapter 10
Teaching and Learning with Technology in English and Language Arts

Robin Jocius, Associate Professor of Literacy Studies
The University of Texas at Arlington
College of Education

Chapter 11
Teaching and Learning Languages with Technology

Veronica G. Sardegna, Adjunct Faculty
Duquesne University
School of Education

Chapter 12
Teaching and Learning with Technology in Science, Engineering, and Mathematics

Tamara J. Moore, Professor of Engineering Education
Purdue University
School of Engineering Education

Chapter 13
Teaching and Learning with Technology in Social Studies

Todd S. Hawley, Professor of Social Studies Teacher Education
Kent State University
School of Teaching, Learning, and Curriculum Studies

Chapter 14
Teaching and Learning with Technology in Music and Visual Art

Jay Dorfman, Associate Professor and Coordinator of Music Education
Kent State University
Hugh A. Glauser School of Music

Chapter 15
Teaching and Learning with Technology in Health and Physical Education

Jingwen Liu, Assistant Professor of Physical Education Teacher Education
California State University, Fullerton
Department of Kinesiology
College of Health and Human Development

Robin Vande Zande, Professor of Art Education
Kent State University
School of Art

The degree of support from the Pearson Education staff is impossible to measure. The logistical challenges of this edition would not have been manageable without the professional oversight and personal direction of our Developmental Editor, Jeffery Johnston. Jeff, you're always so organized; it is a blessing! We would also like to thank Rebecca Fox-Gieg, Senior Content Manager, and Yagnesh Jani, all of whom made this version of the book useful, attractive, and meaningful. Thank you for your indispensable contributions to this text.

From JEH: Being able to collaborate on this book with M. D. Roblyer is a highlight of my career, which has always focused on technology integration in the K–12 classroom. I would like to recognize the guidance and love of my husband, Lee Klancher, during the more-than-a-year-long-during-COVID revision process. As an author of many books and decades of experience in publishing, he provides me the sagest advice which I *should always follow*. He also provided me countless breakfasts and dinners and ordered me to exercise across the year I wrote, edited, and updated this book. Tremendous thanks and gratitude also go out to an amazing doctoral student and former teacher, Anna R. Oliveri, who assisted me with library research as well as many organizational tasks. Most important, I extend heartfelt and generous respect for schools and teachers who choose to participate in research studies. Such participation is the only way the education field begins to understand which innovations work and which do not. Behind every research study mentioned in this book is at least one or more classrooms of students and teachers who opened up their classrooms!

From MDR: In this, the last edition of this textbook to reflect my name as author, I acknowledge ineffable gratitude to retired Pearson editor Debbie Stollenwerk, who first saw the book's potential for transforming perceptions about technology's uses in education and took a chance on a virtually unknown author; and to my family, Bill and Paige Wiencke, whose support enabled me to create the first edition published in 1996, all subsequent ones, and indeed, everything I have been able to accomplish throughout my professional career. I would also like to continue to remember and acknowledge the influences of family who are with us now only in memory: our parents Servatius Lee Roblyer and Phrona Catherine Roblyer and Raymond and Marjorie Wiencke. Finally, my thanks go to Joan Hughes who took over work on this text so it might continue its usefulness in classrooms around the world.

From both authors: We would like to acknowledge all the educators whose perseverance and commitment to their students remains a constant we can count on, especially during the recent COVID-19 pandemic.

—Joan E. Hughes and M. D. Roblyer

Brief Contents

Contents

PART 1 Technology Integration and Leadership in Education

PART 2 Digital Content for Learning

PART 3 Digital Resources for Critical Thinking, Creating, Communicating, and Collaborating in Blended and Online Contexts

APPENDICES

This page intentionally left blank

CHAPTER 1

Educational Technology in Context

THE BIG PICTURE

Learning Outcomes

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

1.1 Analyze how (a) the definition for educational technology and integrating educational technology and (b) the history of digital technology shapes opportunities for integrating educational technology in classrooms. (ISTE Standards for Educators: 1—Learner; 5—Designer)

1.2 Characterize trends in established and emerging technologies and describe how they shape educational innovations. (ISTE Standards for Educators: 1—Learner; 2—Leader; 5—Designer)

1.3 Articulate the impact of leadership, politics and policies, infrastructure, safety, and equity and social justice conditions on current uses of technology in education. (ISTE Standards for Educators: 2—Leader; 3—Citizen; 4—Collaborator; 5—Designer)

TECHNOLOGY INTEGRATION IN ACTION:

Then and Now

Then . . . Ms. Thomas was almost as proud of her new classroom computers as she was of her new teaching degree. She had high hopes for the 1985 school year in her first teaching position, especially because the principal had asked her whether she could use two brand-new Apple computer systems that had been donated to the school.

Ms. Thomas also found MECC software, such as Oregon Trail, and successfully lobbied the principal to buy it. With Oregon Trail, students were transported to 1848 as pioneers traveling from Missouri via wagons to resettle in Oregon. She also discovered Apple **Logo**, with which students could engage in computer programming that controlled a turtle icon that moved and drew lines on the screen. All the students wanted to use the computers, but with only two machines, Ms. Thomas quickly managed the activities to allow everyone to have turns. By the end of the year, she was convinced that these computers led her students to experience learning in different ways, such as through simulated historical experiences or building logic and control with Logo. She expected computers to become an integral part of everyday teaching activities, and she planned to be ready for the future.

(*Continued*)

Now . . . As Ms. Thomas begins another school year, she reflects on her first pioneering work with her Apple computers more than 35 years ago and the technology possibilities available now. She has an **interactive whiteboard**, a device that allows her to project information from a computer to a screen and then manipulate it either with special pens or hands. Ms. Thomas and all her students use tablet computers as part of the school district's **one-to-one computing** initiative for student-centered, hands-on learning. With these devices, her students access science simulations and online math manipulatives, engage in **makerspace** projects, and participate in **citizen science** with others around the state to gather and compare data on local environmental conditions. Students use **graphing calculators** to solve problems, use online programs to learn foreign languages, and take **virtual field trips** in science and social studies. A video project to interview war veterans has drawn a lot of local attention, and the student projects displayed on school digital displays are ablaze with websites and images students had taken with digital cameras.

Ms. Thomas and her teacher colleagues also communicate via email or online chats, and many use a school-approved **learning management system (LMS)** for learning—Google Classroom or Schoology—so that students and parents can get up-to-date information on school and classroom activities and communicate with each other and the teacher. The LMS and the tablets were crucial to continue learning during emergency situations, such as the pandemic, forest fires, and hurricanes.

There were still problems, of course. Computer **viruses** and **spam** sometimes slowed the district's network, and the **firewall** that had been put in place to prevent students from accessing undesirable websites also prevented access to many other perfectly good sites. Teachers reported intermittent problems with **cyberbullying** and inappropriate postings on social network sites despite the school's **acceptable use policies**. Some teachers complained that they had no time for innovative technology-based projects because they were too busy preparing students for the state tests that would determine students' progress, their school's rating, and their own effectiveness scores as teachers.

Despite these concerns, Ms. Thomas is amazed at how far educational technology has come from those first, exciting, exploratory steps she took back in 1985 and how much more there still is to examine. She knows other teachers her age who retired, but she's too interested in what she's doing to retire yet. She's helping with an online program for homebound students and leading a professional development project to support other teachers in using technologies that positions all learners as empowered and agentic. Ms. Thomas is looking forward to the future.

Introduction

Today's educators may think of educational technology as devices or equipment—such as computers, mobile phones, and tablets. But educational technology is not new at all, and it is by no means limited to a list of technical devices or software. Contemporary tools and techniques are simply the latest innovations in a field that is as old as education itself. This chapter introduces our definition of educational technology and the historical perspectives that have contributed to it, the emerging trends that may inspire you, and the conditions that influence the role these innovations may play in the schools you work in today or in the future. In this chapter, you will learn by doing the following:

- **Reviewing key terminology.** Talking about a topic requires knowing the vocabulary and concepts relevant to that topic. We break down the idea of "educational technology" as a resource and a process educators implement in practice.
- **Reflecting on the past.** Showing where the field began helps us understand where it is headed and why. Over time, changes in goals and methods in the field cast new light on the challenges and opportunities of today's technologies.
- **Looking ahead to the future.** Technology resources and societal conditions change so rapidly that today's teachers must be futurists who critically analyze emerging trends.
- **Considering the conditions.** Available technologies may provide possibilities, but a combination of leadership, political, infrastructural, safety, equitable and socially just issues influence the current uses of educational technology.

This text provides you a guided journey through the process of integrating educational technology, as defined in the next section. This chapter provides the big picture, including

key definitions, concepts, and processes involved in integrating educational technology. That process is broken down further in Chapters 2 and 3 where we outline the three parts of our definition of integrating educational technology. Chapter 2 introduces the importance of learning theories, pedagogy, and curriculum. Chapter 3 introduces the roles for technology tools, support, and expertise, culminating with the Technology Integration Planning (TIP) model that teachers use to design technology-integrated lessons for their own classrooms. The TIP model is demonstrated in a *Technology Integration in Action* scenario that begins all subsequent chapters and is the focus of the workshop activities that close each chapter. Chapters 4–7 provide in-depth reviews of digital content resources for learning, communicating, designing, analyzing, creating, and making. Chapter 8 culminates with guidance in using all the resources and planning guides introduced in Chapters 1–7 to build out blended and online learning experiences. The latter half of the book, Chapters 9–15, provide key issues and technology integration strategies for content areas, including special education; English and language arts; English as an additional language and foreign languages; science, engineering, and mathematics; social studies; music and art; and physical and health education. All the technology integration strategies are grounded in strong educational research.

The "Big Picture" of Educational Technology

Learning Outcome 1.1 **Analyze how (a) the definition for educational technology and integrating educational technology and (b) the history of digital technology shapes opportunities for integrating educational technology in classrooms. (ISTE Standards for Educators: 1—Learner; 5—Designer)**

The big-picture review in this section introduces a definition of the term *educational technology* that is built on decades of work in this field. Saettler (1990) says that the earliest references to educational technology were made by radio instruction pioneer W. W. Charters in 1948. Across the last seven decades, unique outlooks on what technology in education is and should be have emerged from different professional organizations, but definitions commonly encompass both technological resources and educational processes. We refer to *education technology* as the ethical and just practice of leveraging technology *resources* to support the educational *processes* involved in teaching and learning. Educational technology is an active, engaged practice; it is not a singular technology tool. It has been built on decades of research and development.

How This Textbook Defines Educational Technology

In this section, we introduce the fundamental processes and resources that contribute to an informed practice of educational technology.

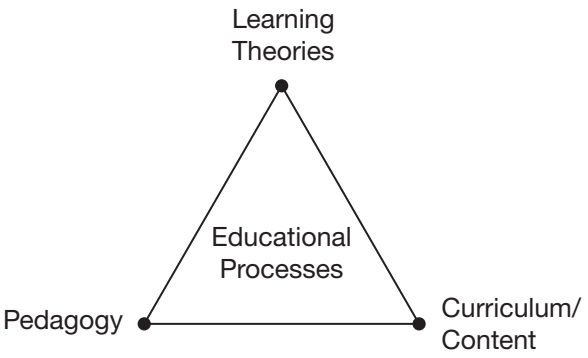
- **Educational technology** refers to the ethical and just practice of leveraging *resources* to support the educational *processes* involved in teaching and learning.
- **Educational processes** include a set of three knowledge areas through which to consider the role of technological resources, including (1) learning theories based on the sciences of human cognition, (2) pedagogical or instructional practices that complement learning theories, and (3) curriculum standards or content knowledge that inform our learning objectives or goals. Chapter 2 reviews these educational processes in depth.
- **Technology resources** in this textbook are viewed as technology tools and technology support and expertise. We choose the term **resource** to capture the supply of both technological tools and human technological support or expertise that exists within people or in resources (e.g., a website or online community) built by knowledgeable others. A technology **tool** is a device such as a **clicker** or software application

such as a word processor or Twitter that accomplishes a specific task. Technological support and expertise exist among school personnel. For example, librarians, media specialists, and other teachers in your school might provide ideas and expertise for using technologies in lessons. Principals might provide special funding for projects you develop. Chapter 3 introduces these resources and describes how teachers can build a community of support for developing and accessing technological expertise. Chapters 4–7 provide even more coverage of available technology tools.

- **Integrating educational technology** refers to an individual or collaborative process of (1) identifying **problems of practice (POPs)** (e.g., learners' needs or misconceptions, lack of culturally relevant curricular materials, difficult teaching topics), (2) accessing technological resources as possible solutions, (3) leveraging the resources in your learning context, and (4) assessing whether the educational technology solves the target POP in ways that replace, amplify, or transform teaching and learning. Chapter 3 introduces the **Technology Integration Planning (TIP)** model to help guide teachers through the process of integrating educational technology.

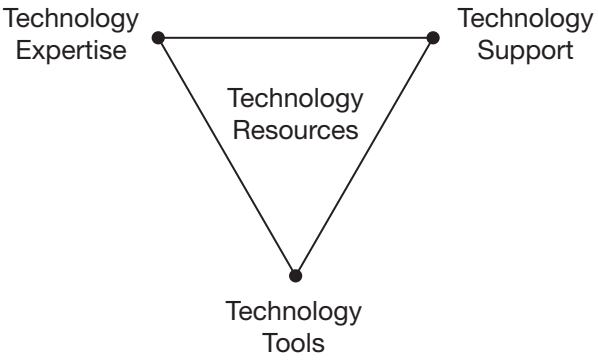
Figure 1.1 visualizes the processes and resources in a framework for integrating educational technology.

Figure 1.1 A Framework for Integrating Educational Technology



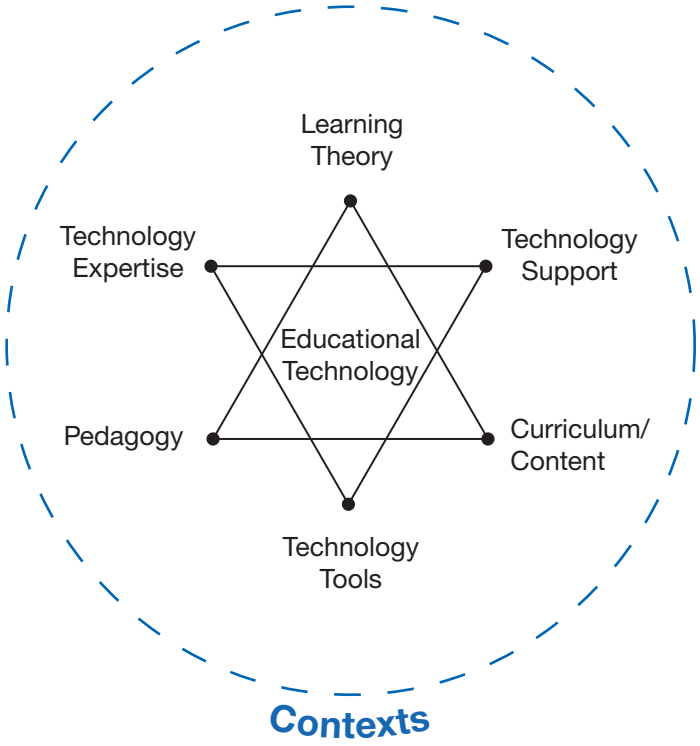
(a) Identify problems of practice.

Identify problems of practice (POPs; e.g., learners' needs or misconceptions, lack of culturally relevant curricular materials, or difficult teaching topics) by consulting the educational processes with which teachers engage every day.



(b) Identify technology possibilities.

Identify possible technological solutions for your POPs by reviewing the technology resources available at your school.



(c) Use and assess educational technology.

Once you choose a technology resource to tackle the target POP in ethical ways that are equitable and empowering for students, you are enacting educational technology. Once you've harnessed educational technology for teaching or learning, you will want to assess its effectiveness in solving the target POP.

Educational Technology Across Time

Our current approaches to integrating educational technology into classrooms have been shaped by decades of developments in digital technologies. The six eras in the history of digital technologies, shown in Figure 1.2, are described in this section.

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

MAINFRAME COMPUTER ERA In the 1950s–1970s, companies like IBM developed instructional **mainframes**, or large-scale computers that were often the size of a room. Researchers used these systems to develop CAI materials that schools used via long-distance connections to the mainframe. CAI was instructional software designed to help teach information and/or skills related to a topic. Companies such as the Computer Curriculum Corporation (CCC) and the Programmed Logic for Automatic Teaching Operations (PLATO) system (developed by Control Data Corporation) dominated the field for about 15 years.

COMPUTER ERA In contrast to mainframes, in the late 1970s and 1980s, small, stand-alone desktop **computers**, designed for use by only one person at a time, became available. School districts placed them directly into the hands of teachers and schools. An educational software publishing movement quickly sprang up to provide teachers and students software to use on computers. Researchers realized both teachers and students required skills in using the computer, and researcher Arthur Luehrmann coined the term **computer literacy**. MIT researcher Seymour Papert contributed to developing **Logo**, a programming language, and used it as an aid to teach problem solving. Networked **integrated learning systems (ILSs)**, which provided computer-based instruction and summary reports of student progress, also were developed to help teachers address required standards.

INTERNET ERA The **World Wide Web (WWW)**, now simply known as the **web**, was invented in the 1990s. This was a system within the **Internet** that allowed graphic displays of websites through hypertext links, pieces of texts or images that allowed users to jump to other locations connected by the links. Teachers and students used **browser** software to explore information on the web, and by the beginning of the 2000s, email, web-based multimedia, and videoconferencing became standard tools of web users. Websites became a primary form of communication for educators, and web-based distance education became a more prominent part of instructional delivery at all levels of education. The meaning of "online" changed from simply being on the computer to being connected to the web. **Virtual schools**, which facilitate learning when K–12 students and teachers are physically separated and instruction is synchronous or asynchronous, began a steady growth that has endured in public, charter, and private education.

THE MOBILE TECHNOLOGIES, SOCIAL MEDIA, AND OPEN ACCESS ERA In the early 2000s, portable devices such as smartphones and tablets made web access and computer power more ubiquitous. More and more individuals made texting and social networking sites, such as Facebook, Twitter, and Instagram, part of their everyday lives. The ease of access to online resources and communications drove several movements.

- **Distance learning.** A dramatic increase in the number and type of distance learning offerings came about first in higher education and then in K–12 schools.
- **Electronic books** (**e-books** or **e-texts**). Texts in digital form on computers, e-book readers, and smartphones became increasingly popular alternatives to printed texts.
- **Open access.** Initiatives began to gather learning materials and make them available "**open**" online, which means that anyone can access them for free and modify, remix, and reuse the content with appropriate attribution and without fees for others' use. **OpenCourseWare (OCW)** and open-access university offerings called **Massive Open Online Courses (MOOCs)** became available.
- **Mobile access.** One-to-one laptop programs (and later tablet programs) as well as **Bring Your Own Device (BYOD) programs** allowed students to use their own handheld devices for learning activities and accelerated the move to bring computer and Internet access into all classrooms.

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

THE PERSONALIZED, ADAPTIVE LEARNING ERA Innovators began building personalized, adaptive learning software that is similar to, yet more powerful than, the CAI and ILS systems of the mainframe and computer eras. By recording every click of a mouse, this adaptive learning software can adjust to learners' needs through sophisticated analysis of learner behaviors and interactions with resources or content. This software adapts immediately by changing content, activities, and assessments to create a personalized learning path for each student. Most textbook publishers and app developers are building adaptive technology into their new products. For example, Dreambox Learning is adaptive math software with game-based elements. In many cases, a data dashboard is available for the teacher and school leaders and sometimes for the learner and parent. Teachers can use the dashboard to examine individual student progress and provide further interventions as needed. School leaders can use dashboards to discover patterns in students' learning needs. However, some controversy has emerged about these innovations, such as parents and students expressing dissatisfaction with Summit Learning personalized platform and curriculum in their districts (Bowles, 2019).

THE DIGITAL JUSTICE ERA With growing educational commitments to social justice, the work of many researchers and practitioners to identify more equitable, inclusive, and antiracist or anti-oppressive educational technology is becoming an imperative. This work raises critical questions regarding the content and functionality of software and hardware; the access to digital connectivity and resources; and the ways resources are used by teachers, students, and parents. For example, some worry that the vast data collected about learners might be harmful (Shulman, 2016), and concerns have arisen regarding ownership, control, access, use, security, and privacy of the data.

BOX 1.1 DIGITAL EQUITY AND JUSTICE

Definitions and Goals

As a nation, we have not yet achieved **digital equity**, which is "a condition in which all individuals and communities have the information technology capacity needed for full participation in our society, democracy and economy. Digital Equity is necessary for civic and cultural participation, employment, lifelong learning, and access to essential services" (National Digital Inclusion Alliance, n.d.). Visit the U.S. Census' latest American Community Survey to explore your state's digital equity gap in terms of the percentage of households (1) lacking wired home broadband connections, (2) having no home Internet of any kind, and (3) having an Internet subscription by income level (e.g., below $20,000 and above $50,000/year).

As educators, we must work toward achieving digital equity, through **digital inclusion**, which are activities we can do to ensure all individuals and communities, especially groups that have been identified as having endured **digital inequities**, have access to and use technology. Five important elements of inclusion are:

1. Affordable, robust broadband Internet service
2. Internet-enabled devices
3. Digital literacy training
4. Technical support
5. Applications and online content that enable self-sufficiency, participation, and collaboration (**National Digital Inclusion Alliance, n.d.**).

In terms of schools and children, educators must constantly monitor the degree to which all children have access to Internet-ready device(s), high-speed Internet, and just-in-time technical support so they can develop applicable digital literacy competencies and use apps and digital content that privilege high-quality learning experiences that involve participation, collaboration, and student agency in the activities. These elements of digital inclusion have been argued to be a human right (Cancro, 2016), a civil rights issue (Krueger & James, 2017), and instrumental for societal progress (Gonzales, 2016). Thus, as an expression of social justice, our nation's schools and educators must actively seek **digital justice** wherein we identify and eliminate historical, institutional, and structural barriers to access and use technology for learning in classrooms, schools, homes, and communities.

National and state emergencies that closed schools brought attention to enduring digital inequities, such as lack of access to high-speed Internet, digital devices, and software for online learning within children's homes and communities. Others question if software is anti-oppressive and supports humanizing pedagogy, such as considering software that compels teachers to rate students' behaviors or online test proctoring that introduces surveillance into learners' homes as forms of oppression.

How What We Have Learned from the Past Shapes our Future

To help us become more equitable and effective technology users today, we can apply what we know about the past to future decisions and actions. Developments in digital technologies along with societal changes have shaped the history of educational technology. The following points are among the most important.

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

Teachers usually do not develop technology materials or curriculum. Teaching is one of the most time- and labor-intensive jobs in our society. With so many demands on their time, most teachers do not develop software or create complex technology-based teaching materials. Publishers, software companies, school or district developers, researchers, and most recently, philanthropic organizations have provided the majority of this assistance. Yet, teachers have the important responsibility to vet these materials for appropriateness and equity.

"Technically possible" does not equal "desirable, feasible, or inevitable." Technology can bring undesirable—as well as desirable—changes. For example, increased access to cell phones and tablets in classrooms means that online communication and information are increasingly available. But communication always comes with caveats, and readily available information is not always reliable or helpful. New technological horizons require teachers to analyze carefully the implications of each implementation decision. Better technology demands that we become critical consumers of its power, capability, and inequity. We are responsible for deciding just which educational technology becomes reality in our classrooms.

Technologies change faster than teachers can keep up. The history of educational technology has shown that resources and accepted methods of applying them will change, often quickly and dramatically. The need to continue learning new resources and to change instructional methods places a special burden on already overworked teachers. Educators might not be able to predict the future of educational technology, but they know that it will be different than it is in the present; that is, they must anticipate and accept the inevitability of change and the need for continual learning.

Many technologies do not change educational practices. Technology in education is an area especially susceptible to fads. The past has shown that teachers must be careful, analytical consumers of technological innovation, looking to what has worked in the past to guide their decisions and measure their expectations in the present. Educational practice tends to move in cycles, and "new" digital methods are often old methods in new guise. In short, teachers must be as informed and analytical to ensure new digital resources offer advantages over current instructional practices.

Teachers will always be more important than technology. The developers of the first instructional computer systems in the 1960s foresaw them replacing many teacher positions; some advocates of today's online learning methods and personalized learning systems envision a similar impact on future education. Yet good teachers are more essential now than ever. We need more teachers who understand the role that technology plays in society and in education, who are prepared to take advantage of its power, and who recognize its limitations. In an increasingly technological society, we need more teachers who are technology savvy, critically aware, and child centered.

Established and Emerging Educational Technology Trends

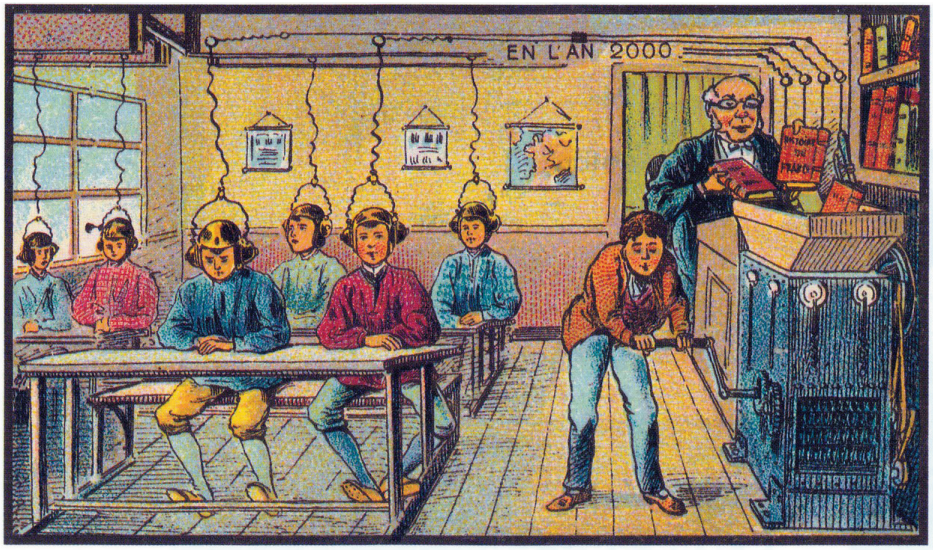
Learning Outcome 1.2 **Characterize trends in established and emerging technologies and describe how they shape educational innovations. (ISTE Standards for Educators: 1—Learner; 2—Leader; 5—Designer)**

Visions of the future are suffused with images of technologies that may seem magical and far-fetched. Figure 1.3 is most likely attributed to French artist Jean-Marc Côté, who envisioned that a century later, in the year 2000, a technology could grind books' content and insert information and knowledge directly into students' heads. While this invention has never come to be, we know that future education may have access to innovations that leverage current technical inventions. Educators must identify how to take advantage of their capabilities to bring about the future education systems that advance a democratic society.

Figure 1.3 A postcard from circa 1901 depicting how French artist Jean-Marc Côté envisioned education a century later in the year 2000. The image connotes a teacher who pushes content information from books through a machine that transports the information into students' heads via wired ear/head caps while they sit passively at tables in rows in a classroom.

Public Domain:

https://commons.wikimedia.org/wiki/Category:France_in_XXI_Century_(fiction)#/media/File:France_in_XXI_Century._School.jpg



At School