Chapter 13
Digital Technologies and Assessment in the Twenty-First-Century Schooling

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Introduction

The rapid development of information and communication technologies (ICT) has significantly changed the ways in which today's children entertain, socialize, and learn. The digital society in the twenty-first century requires a suite of cognitive and psychological abilities and perspectives that enable the individual to intelligently consume and creatively develop digital products, and ethically lead or participate in a world that has become increasingly mediated by technology. How can today's education help our students, the next generation of responsibility (Generation R), develop technological competencies for surviving and thriving in the twenty-first century?

In this chapter, we address this question by envisioning school assessments that focus on technological competencies. Our discussions center on the following aspects: the critical skills students need to equip with in terms of digital technology, assessment of student digital technology proficiencies, and the indicators of strong digital competencies. Specifically, we will first review the role of digital technologies in the twenty-first century. Second, we examine what technology proficiency is necessary for the Generation R to fully participate in the society in the twenty-first century. Third, we discuss how the concept and standards of digital proficiency have evolved over the last several decades, corresponding to the rapid development and adoption of modern digital technologies. And fourth, we investigate how student digital technology proficiency has been assessed and discuss what schools need to do to better prepare their students with proficient digital literacy.

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Workforce for the Digital Technologies in the Twenty-First Century

With the rapid development of modern technologies, it is reasonable to expect that today's students will need a whole new set of digital technology skills and abilities as they enter the workforce. Technology has penetrated all aspects of our everyday lives, creating a digital society. People entertain, socialize, do business, go to school, and participate in government in an ever-expanding digital universe (Horrigan 2008; Lamb 2006). In 2006, Americans spent approximately $227.6 billion online, a 9 % increase from the previous year (comScore 2011). Increasingly, the economy worldwide is driven by information and communication technologies (ICT) (Barlow et al. 2007; United National Conference on Trade and Development (UNCTAD) 2008). In 2006, ICT-producing and ICT-using industries contributed half of the acceleration in US economic growth (Jorgenson et al. 2005; Jorgenson 2005). The Bureau of Labor Statistics (BLS) estimates that ICT occupations will increase by 40 % between 2004 and 2014, a rate more than three times faster than the growth of the overall workforce, and most of the fastest-growing occupations require ICT skills (Hecker 2005). There is no doubt that our world will be further digitized (Livingstone and Kemp 2006; Prensky 2005). It is predicted that by the year 2020, virtual reality on the Internet will come to allow more productivity from most people in technologically-savvy communities than working in the "real world" (Anderson and Rainie 2006).

As pointed out by Zhao (2009), the technology-mediated world differs from the traditional world in fundamental ways, including the tools required for participation, the rules that govern activities, and the consequences of participation. Competent citizens of the digital economy need a sound understanding of the nature of the digital world, a positive attitude about its complexities, and the ability to create digital products and services in order to participate in and lead its activities. Schools need to prepare students to be contributing members and creative leaders in the digital era.

In the USA, the need to prepare students with the ability and skills needed to participate fully in the increasingly technological society has been a long-standing priority (U.S. Department of Education 2000). Since the early 1980s, reports on the needs and crises in education have explicitly addressed the need to prepare students to be part of a computer literate workforce (Urban-Lurain and Zhou 2004). *A Nation at Risk* frames the "risk" in the context of a workforce that may not be prepared to compete in a global economy that is driven by technology (The National Commission on Excellence in Education 1983). The US Department of Education has publicized three national technology plans, in 1996, 2000, and 2004, respectively. The need to improve student technology ability and skills is emphasized explicitly in all national technology plans. The first national information technology plan—Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge (June 1996)—states

> Our economy is characterized by rapidly changing technologies and increasing international economic competition. And, our society is complex, diverse, and mobile. Success as a nation will depend substantially on our students' ability to acquire the skills and knowledge necessary for high-technology work and informed citizenship. (p. 00)

In the second technology plan, one of the five goals is "All students will have technology and information literacy skills" (p. 00). And the third national educational technology plan continues to stress:

> Over the next decade, the United States will face ever increasing competition in the global economy….To an overwhelming extent, this competition will involve the mastery and application of new technologies in virtually every field of human endeavor… It is the responsibility of this nation's educational enterprise– including policymakers – to help secure our economic future by ensuring that our young people are adequately prepared to meet these challenges. (U.S. Department of Education 2004)

How we might help students make full use of available information technologies and improve their technology proficiency has become a critical issue facing educators and educational researchers. In the last two decades, much attention has been paid to students' technology proficiency, especially that of K-12 school students, including investigation on current student technology use, conditions for student technology use, and the ways technology use might help improve student technology proficiency.

The Evolution of Student Digital Literacy

Student digital literacy has evolved greatly over the last several decades, tracking the rapid advance of digital technologies and the cultural, political, and economic changes in our society. By reviewing educational technology policy documents and national standards on student education technology proficiency, we examine how the requirement of student technology proficiency has changed over time.

Diverse Interpretation of Digital Literacy

What is deemed necessary for student technology abilities differs at varying stages of technology development. A review of research and policy documents reveals different terms related to technology proficiency, such as "information literacy," "computer literacy," "technology literacy," "information competence," and "media literacy." The following definitions are examples:

- "Technological literacy": computer skills and the ability to use computers and other technology to improve learning, productivity, and performance (U.S. Department of Education 1996).
- "Information literacy": the ability to know when there is a need for information and to be able to identify, locate, evaluate, and effectively use that information for the issue or problem at hand and as "a constellation of skills revolving around information research and use" (The National Forum on Information Literacy n.d., p. 00)

- "Information communication and technology (ICT) literacy": using digital technology, communication tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society (The Educational Testing Services 2002)
- "Digital literacy": the ability to find, evaluate, utilize, and create information using digital technology (Cornell University Digital Literacy Resources 2009)

Even for the same term, the definition has in cases evolved over the years, reflecting the changing expectations of technology proficiency. For example, the term "information literacy" has been interpreted differently:

> the skills of information problem solving. (Wisconsin Educational Media Association 1993, p. 00; c.f., the Associated Colleges of the South 1999)
>
> a new liberal art that extends from knowing how to use computers and access information to critical reflection on the nature of information itself, its technical infrastructure, and its social, cultural and even philosophical context and impact. (Shapiro and Hughes 1996, p. 00)
>
> the ability to locate, evaluate, and use information to become independent life-long learners. (Commission on Colleges, Southern Association of Colleges and Schools (SACS) 1996, p. 00)
>
> a wholistic, interactive learning process encompassing the skills of defining, locating, selecting, organizing, presenting, and evaluating information. (Steele and Stewart 1998, p. 00)
>
> the ability to search for, find, evaluate, and use information from a variety of sources. (Goad 2002, p.21)

Despite the alternate definitions developed by various educational institutions, professional organizations, and individuals, the term "information literacy" calls for individuals being "able to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information" (Presidential Committee on Information Literacy 1989, p. 1). We note that a piece of "information" in the digital era can be presented in various formats including print, visual, and computer-based network (Plotnick 1999).

In addition to defining digital technology proficiency from various perspectives, substantial effort has been devoted to clearly identify the essential digital technology skills and abilities. Below, we briefly summarize the essential components of digital literacy for students as stated in different standards and national documents published in the last two decades.

The Essential Components of Student Digital Literacy Before the Twenty-First Century

Much effort has gone into creating national technology standards for students. For example, in 1998, the American Association of School Librarians and Association for Educational Communications Technology (1998) published The Nine Information Literacy Standards for Student Learning, which defined nine information literacy standards in three categories: (1) information literacy, including three standards—to access information efficiently and effectively, to evaluate information critically and competently, and to use information accurately and

creatively; (2) independent learning, including three standards—to pursue information related to personal interests, appreciate literature and other creative expressions of information, and strive for excellence in information seeking and knowledge generation; and (3) social responsibility, the student who contributes positively to the learning community and to society is information literate and recognizes the importance of information to a democratic society, practices ethical behavior in regard to information and information technology, and participates effectively in groups to pursue and generate information.

In 1998, the International Society for Technology in Education (ISTE) developed the first set of National Educational Technology Standards for Students (ISTE 1998). This document focuses specifically on technology as a tool for students. It suggested that a technologically literate student should master the following six classes of skills and abilities: (1) basic operations and concepts—students demonstrate a sound understanding of the nature and operation of technology systems; (2) social, ethical, and human issues—students understand the ethical, cultural, and societal issues related to technology; (3) technology productivity tools, students use technology tools to enhance learning, increase productivity, and promote creativity; (4) technology communication tools, students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences; (5) technology research tools, students use technology to locate, evaluate, and collect information from a variety of sources; and (6) technology problem-solving and decision-making tools, students use technology resources for solving problems and making informed decisions (ISTE 1998).

In 1999, the Committee on Information Technology Literacy of the US National Research Council (NRC) published a document entitled *Being Fluent with Information Technology*. This document outlined an information technology fluency framework that included three kinds of knowledge: (1) contemporary skills and ability to use today's computer applications to apply information technology immediately—skills provide a store of practical experience on which to build new competence; (2) foundational concepts, the basic principles and ideas of computers, networks, and information underpin the technology—concepts explain the how and why of information technology and give insight into technology's opportunities and limitations; and (3) intellectual capabilities to apply information technology in complex and sustained situations, ten specific skills/capabilities were also proposed for each kind of knowledge. These three kinds of knowledge prepare a person in different ways for FITness:

> FITness requires that persons understand information technology broadly enough to be able to apply it productively at work and in their everyday lives, to recognize when information technology would assist or impede the achievement of a goal, and to continually adapt to the changes in and advancement of information technology. FITness therefore requires a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem solving than does computer literacy as traditionally defined. (p. 15)

In 2000, the second American national information technology plan (U.S. Department of Education 2000) included the following as necessary skills students should learn: task definition, information-seeking strategies, location and access, use of information, synthesis, and evaluation. In this context, evaluation focuses on how

well the product meets the original task (effectiveness) and on how well students carried out the problem-solving process (efficiency).

In summary, a close examination of the technology standards in the last decade of the twentieth century reveals that these documents emphasize the ability of using information technology to find useful information, including searching, locating, and evaluating information; to use information to solve problems; to learn new technologies; and to understand the social and ethic issues related to technology use. The concepts and standards of digital technology proficiency in the 1990s mostly view students as information consumers and emphasize mostly the abilities and skills to use digital technologies.

The New Development of Student Digital Literacy in the Twenty-First Century

As we enter the twenty-first century, with the dramatic development of information technology and its unprecedented impact on society, focusing on technology skills seems insufficient. Instead, a more holistic view of student digital literacy has started to emerge, and this view includes how to prepare students not only how to be information consumers but information creators, as well. For example, the iSkills™, developed by researchers at the Educational Testing Services in 2007 (Katz 2007), proposed an ICT literacy framework which includes the following areas of abilities: (1) define, understand and articulate the scope of an information problem in order to facilitate the electronic search for information; (2) access, collect and/or retrieve information in digital environments; (3) evaluate, judge whether information satisfies an information problem by determining authority, bias, timeliness, relevance, and other aspects of materials; (4) manage, organize information to help you or others find it later; (5) interpret and represent information; (6) create—adapt, apply, design, or construct information in digital environments; and (7) communicate—disseminate information tailored to a particular audience in an effective digital format.

Similarly, in 2007, ISTE publicized the National Educational Technology Standards for Students. This set of standards also recommends six (but considerably different) areas of skills and abilities: (1) creativity and innovation—students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology; (2) communication and collaboration, students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others; (3) research and information fluency, students apply digital tools to gather, evaluate, and use information; (4) critical thinking, problem-solving, and decision-making—students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources; (5) digital citizenship, students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior; (6) technology operations and concepts, students demonstrate a sound understanding of technology concepts, systems, and operations (ISTE 2007).

As Zhao and Lei (2009) note, the penetration of information technology into every aspect of society has created an increasingly digitalized world. They propose that competent citizens of the digital world and the digital economy need to have digital citizenship: (1) knowledge of the nature of the digital world, (2) ability to use different tools to participate in the digital world, (3) ability to create digital products and services and to lead in the digital world, and (4) positive attitude toward the digital world (Zhao 2009; Zhao and Lei 2009). They point out that digital technology abilities in the twenty-first century need to be expanded from being intelligent consumers to enhanced abilities of being creative and contributing members and effective leaders. Schools need to prepare students to actively participate in, create, and lead the coming digital society.

The KPCL Framework

From an extensive examination of the literature, especially on the digital competencies proposed by Zhao (2009), we summarized the Knowing, Participating, Creating, and Leading (KPCL) framework of digital technology literacy for the twenty-first century: (1) Knowing—having a sound understanding of the nature of the digital technologies and the social, cultural, legal, and political responsibilities of using digital technologies; (2) Participating—having the abilities to use digital technologies to actively participate in activities; (3) Creating, having the abilities to use digital technologies to create digital products and services; (4) Leading, assuming the leadership role in using and creating digital technologies to transform the social and natural environments. Table 13.1 identifies critical aspects of the framework and their associated specific indicators.

This new perspective extends the gap between how schools should evaluate student digital literacy and how schools usually do, a topic to which we now turn.

Assessing Student Digital Literacy

Although the importance of preparing students with digital literacy is widely accepted, both the research and practice on assessing digital literacy have been lagging. In the USA, as of 2005, only two states reported having a statewide assessment of students' technology skills, 11 states had a statewide assessment planned, and 13 states indicated that individual districts administered technology literacy assessments to students (Bakia et al. 2007). By 2009, 13 states reported having tested students' knowledge of technology (Hightower 2009). As more states and districts add student technology assessments, the question of how to accurately assess students' technology literacy becomes increasingly important. Our review of the literature on assessments of digital literacy revealed various methods for determining if students have the technology skills needed to be successful in an increasingly technological world.

Table 13.1 The Knowing, Participating, Creating, and Leading (KPCL) framework of digital technology literacy in the twenty-first century

Aspects of digital technology literacy	Specific indicators
Knowing: having a sound understanding of the nature of digital technologies and the social, cultural, legal and political responsibilities of using these technologies	Understand the variety of digital technologies and the nature of the digital technologies Understand the social, cultural, legal, and political responsibilities of using digital technologies
Participating: being able to use digital technologies to actively participate in activities of different communities	Use various digital technologies regularly Participate in the activities of different communities with the aid of digital technologies
Creating: being able to use digital technologies to create digital products and services and craft new ways of disseminating knowledge	Transform the traditional use of digital technologies Create new digital products and services Craft new ways of disseminating knowledge
Leading: assuming leadership roles in using and creating digital technologies to transform the social and natural environments	Lead the development of new technologies Lead the transformation of the social and natural environments using digital technologies

The various digital literacy assessments found in the literature fall into three main categories: (a) self-report questionnaires, (b) online skills assessments, and (c) portfolio-based assessments. Each category is summarized below, and examples are included to provide context for how these tools are being used with students.

Self-report questionnaires are instruments that ask students to rate their own competency on various computer applications and technology skills (Keengwe and Anyanwu 2007; Salaway et al. 2008). Such self-report instruments have been used primarily with university students or adults. For example, in the ECAR Study of Undergraduate Students and Information Technology (Salaway et al. 2008), the researchers used an online self-report questionnaire to assess the technology skills of over 27,000 undergraduate students. The assessment instrument requested students to rank their use of specific software applications (such as spreadsheets, presentation software, and Internet search engines) on a scale from *Not at all skilled* to *Expert* (p. 105). In addition to this type of measurement, the questionnaire included items on students' ownership and use of various technology tools and applications, as well as their preferences for technology use in learning environments. Similarly, McCoy (2010) required undergraduate students to rank their ability to complete tasks such as "sending and receiving electronic mail" and "browsing the Internet" using a 1–4 Likert scale (p. 1617). Morahan-Martin and Schumacher (2007) surveyed over 400 undergraduate students by having them rank their skills on a four-point scale, from poor to expert, on eight technology applications such as word processing, Internet use, and creating a web page.

Online skills assessments test students' technology literacy through a combination of performance-based tasks and multiple-choice questions. These online assessments are self-scoring and most such systems also store student data, so they provide an

all-in-one solution for many states and schools (Roland 2006). Judson (2010) used data from the TechLiteracy Assessments™ (TLA) administered by Learning.com to analyze the technology literacy of 10,000 fourth-through seventh-grade students in Arizona. TLA is designed to measure students' actual skills rather than their perceptions or dispositions. The TLA assessment consists of a combination of multiple-choice knowledge-focused questions and performance questions requiring students to complete a technology-based task. Aligned with the International Society for Technology in Education (ISTE) National Educational Technology Standards for Students (NETS*S) (2011), this assessment measures digital literacy in seven categories: (1) system fundamentals, (2) social and ethical issues, (3) word processing, (4) spreadsheets, (5) multimedia presentation, (6) telecommunication, and (7) databases (Judson 2010, p. 276). The assessment is criterion referenced and has been validated with over 8,000 students nationwide (Judson 2010; Learning.com 2011). Other online skills assessments for K-12 students have similar features in that they contain a combination of multiple-choice and performance-based questions, are aligned with the ISTE NETS for students, are computer scored, and are designed to be completed in one class period, making administration easy for teachers and students (Atomic Learning 2011; Hohlfeld et al. 2010; InfoSource 2011; Roland 2006).

Portfolio-based assessments require students to complete a series of activities or projects to demonstrate their ability to use technology resources in various applications. Portfolios are completed over the course of months or even years and are designed to help students build and demonstrate competency (Boone 2009; U.S. Department of Education 2011). The state of West Virginia uses a statewide portfolio-based assessment system, called *techSteps*, to assist their students in building portfolios, showing student growth in digital literacy (Boone 2009; Tullis 2010). Aligned with both the NETS for Students and the West Virginia State technology standards, *techSteps* provides approximately six technology-based lessons per grade level that students complete over the course of the school year. During the lessons, the students create a technology artifact that is scored using rubrics that assess whether the student has demonstrated literacy in the specific areas addressed by the lesson (SchoolKit 2011). Artifacts and rubrics are kept in a student's "personal technology literacy profile" (Boone 2009, p. 69) which provides evidence of their technology literacy throughout their K-8 school career. While techSteps is a statewide initiative in West Virginia, the lessons and assessments must be implemented by teachers at the school level.

A similar portfolio-based system, TechYES, gives students the responsibility for their own technological literacy by creating meaningful projects that demonstrate their ability to use technological tools in real-world applications. TechYES is implemented at the school level, for it requires involvement of instructors working with TechYES students. Completed projects are assessed using rubrics and scores from multiple projects and establish a student's overall technology literacy score, which is then compared to a minimum proficiency cut score in order to determine if the student is digitally literate (Generation YES 2011). Like *techSteps* and TechYES, portfolio-based systems are often technology curriculum and technology assessment in one package (U.S. Department of Education 2011).

Although flexible strategies have been developed to assess student digital technology knowledge, skills, and abilities, additional efforts are needed to develop specific digital literacy instruments that are based on sound theories, designed using scientific assessment methods, and supported and validated by empirical research. One example is the iSkills™ assessment, developed by the Educational Testing Services (ETS) in partnership with a consortium of institutions of higher education. The iSkills™ assessment includes two subsets of assessment: the Core iSkills assessment that measures the ICT literacy skills of students who are making the transition from high school to the first year of postsecondary education and the Advanced iSkills assessment that measures the ICT literacy skills of students who are making the transition either from second-year postsecondary education to third year or the workforce.

In the report titled *Tech Tally: Approaches to Assessing Technological Literacy* published by the National Academy of Engineering, & National Research Council (2006), the committee identified 28 technology assessment instruments, most of which were aimed at K-12 students, and found that none of them provided an adequate measure of technological literacy. The committee offered the following suggestions for future assessments: assessment of digital literacy should (1) begin with a clear purpose in mind; (2) take into account research findings related to how children and adults learn, including how they learn about technology; (3) be based on rigorously developed learning standards, (4) provide information about all three dimensions of technological literacy—knowledge, capabilities, and critical thinking and decision-making; (5) be free of gender, culture, or socioeconomic bias; and (6) be accessible to people with mental or physical disabilities. They also provided recommendations in five categories: opportunities for assessment, research on learning, the use of innovative measurement techniques, framework development, and broadening the definition of technology (pp. 176–177).

What Schools Need to Do

Schools need to prepare students with skills for the digital economy. Today's children, the "digital natives" (Prensky 2001), are not necessarily competent digitally responsible citizens. However, adults, assuming the role of "digital immigrants," often leave children's technology exploration on their own (Livingstone 2008). Schools are not preparing students with the necessary skills, knowledge, and responsibilities to face the challenges and to live and work competently in the digital society. In fact, schools are falling behind their students in using technology (Education Week 2007; Hitlin and Rainie 2005: Levin and Arafeh 2002). More than half of parents and teachers who participated in the Speak Up 2006 survey said their schools are not doing a good job of preparing students to compete for jobs and careers of the twenty-first century (Project Tomorrow 2007).

Based on the KPCL framework, we suggest that schools can improve this situation from several aspects. First, schools should not mistake "access" to technology

as digital literacy. The last two decades have witnessed strong advocacy and heavy investment in equipping schools with computers and Internet connection for all students (U.S. Department of Education 1996, 2000, 2004). However, access to technology does not necessarily lead to the actual use of technology or to development of KPCL abilities. Despite dramatically increased access to technology, in many schools, computers remain "oversold but underused" (Cuban 2001; Education Week 2005, 2007; U.S. Department of Education 2004). Schools need to make better use of available technologies, integrate technology into teaching and learning in meaningful ways, and help students take advantage of the opportunities afforded by digital technologies. For example, in the last a few years, the widespread use of social-networking websites, data-sharing websites, blogs, podcasting and wikis is making the Internet more important than ever. Schools can use the popularity of Web 2.0 technologies to strengthen teaching and learning. Teachers can use wiki web pages as a venue to have students collaborate on authentic learning tasks. Blogging can be used not only by teachers to reflect on their own teaching but also by students to reflect on their learning, voice their opinions on educational values, and communicate with their peers, friends, and teachers. Social-networking websites such as Bebo, MySpace, Facebook, and Twitter also provide new opportunities for creative teaching and learning and new ways to participating in schooling.

Second, schools need to go beyond traditional technology education practices and concepts such as "technology literacy," "information literacy," "computer literacy," and "computer education" that mainly focus on only using technology hardware and software or searching, selecting, and using information as information consumers (e.g., Goad 2002, p. 21). Instead, schools need to help students expand their understanding of the nature of technology and its role in the digital world (Campbell 1998; Yannie 2000) and to better prepare students for transitioning from being mere consumers of information to taking on multiple roles as "producers, collaborators, researchers and publishers" (Stead 2006).

Third, schools need to help students to build capabilities for coping with challenges in the digital world and for developing the responsibility to resolve such challenges. Without adequate preparation for the coming digital world, today's students face a number of challenges. Schools need to help bridge the gap between being technology savvy and being digitally literate. Today's children are much more technology savvy than previous generations (Prensky 2001; Rideout et al. 2005; Tapscott 1998). However, being able to use technology does not necessarily mean being able to use technology critically, wisely, or meaningfully. The digital generation often falls short in demonstrating the fundamental understanding of digital media (Heverly 2008). Children's superficially competent use of technology can conceal the narrow scope of the activities, the ineffectiveness of online searches, and the lack of in-depth exploration. Such use is often curtailed by the lack of interest in information and poor skills in searching and evaluating information (Livingstone 2008, pp. 103–106). Researchers find that students have difficulty in judging the legitimacy of information (Eastin et al. 2006). A recent report by the Educational Testing Service reveals that only 24 % of first-year community/technical college students and 39 % of 4-year college freshmen meet or exceed the core

foundational level of ICT literacy skills, and only 27 % of these students meet or exceed the intermediate foundational ITC literacy skills (Tannenbaum and Kartz 2008). This finding calls for an urgent need to develop these skills from an earlier stage, especially among middle school students.

Fourth, schools need to prepare students to be responsible digital citizens who understand the social, cultural, and legal consequences of their digital behaviors. Researchers point out that risky behaviors that can happen in real life are also happening in the digital world (Irvine 2006; LeClaire 2006). Most parents and teachers are increasingly concerned with privacy and online safety issues associated with technology use (Project Tomorrow 2007). Among the issues are privacy, online victimization, security threats, and cyber crime. For example, despite the common use of filters and monitoring software in schools, more students are exposed to online pornography, harassment, and cyber bullying (eSchool News 2007; Wolak et al. 2006). Not realizing how much information they are revealing online (Irvine 2006), young people are easy targets of spoofing websites (Dhamija et al. 2006). Aside from becoming potential victims of cyber crime, young people also are at risk of getting involved in committing cyber crimes without an understanding of the consequences (McAfee 2006; Marks 2006). Schools need to help students develop a sound understanding of the good, the bad, and the ugly of the digital world; to understand the social, cultural, and legal consequences of their digital behaviors; and thus to act as responsible citizens in the digitalized world. Schools need to engage students as leaders of the digital world who can voice their thoughts, values, and concerns.

Conclusions

In this chapter, we reviewed the history of technology integration in schools, discussed the importance of digital technology proficiency in the twenty-first century, and examined the evolution of various concepts, definitions, and essential components of digital literacy, with an emphasis on digital literacy in the twenty-first century. We also examined how digital literacy is being assessed and discussed and what schools need to do to prepare students with digital technology abilities and skills needed to be effective in the twenty-first century. We conclude that, with the rapid development and adoption of modern digital technologies in society and among students, what is considered as essential technology skills and abilities has changed over the past several decades, evolving from emphasizing specific technology skills to focusing on a more holistic view of an integrated set of skills and abilities, ranging from using digital technology skills for various tasks to problem-solving abilities, critical thinking, and digital citizenship. Correspondingly, to prepare students with the necessary digital technology proficiency, schools need to go beyond technology education practices and concepts that mainly focus on only using technology hardware and software and on students' role as consumers of digital technology products and services, to emphasize a deeper understanding of the nature of technology and

better prepare students to be responsible participants, active contributors, and effective leaders in a digital society. In terms of assessment, various flexible strategies have been developed to assess student digital technology knowledge, skills, and abilities. However, what is needed are specific digital literacy instruments that are based on sound theories, designed using scientific assessment methods, and supported and validated by empirical research. Future assessments must begin with a clear goal, assess all components of technological literacy, and be sensitive to how technology learning takes place. They also should be based on learning standards, be nonbiased, be accessible to all learners, and use multiple assessment methods to assess development over time.

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