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Navigating the Digital Horizon: A Proposed Framework and Strategies for Assessing Digital Literacy

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Navigating the Digital Horizon: A Proposed Framework and Strategies for Assessing Digital Literacy

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Abstract

Digital literacy skills are essential for success in today's social, academic, and professional environments. This paper introduces a digital literacy framework, outlining key subskills and skill indicators for high school students, grounded in prior research and K–12 educational standards. We examine the implementation of digital literacy assessments in K–12 education and offer recommendations for their integration into educational systems. Our goal is to support the thoughtful development, assessment, and feedback processes necessary to foster students' digital literacy skills.

Keywords: digital literacy, skills, competencies, assessment, competency-based education, portrait of a graduate

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Introduction

Prioritizing digital literacy in K–12 education is imperative given the urgency to equip students with adaptable skills in an ever-changing digital environment, to maximize their potential for success in an increasingly automated workforce, and to support them in developing skills to effectively engage with digital technologies (OECD, 2021). As technology and the use of digital devices continue to envelop students' daily lives, it is becoming increasingly apparent that digital literacy is a fundamental skill for navigating the modern world. However, traditional approaches to defining digital literacy fall short by focusing primarily on technical skills while

overlooking the deeper need to prepare students with more sophisticated skills to critically engage when consuming and creating digital content (Breakstone et al., 2018). For example, many existing digital literacy frameworks fail to address skills for critically evaluating online content, such as recognizing misinformation, detecting biases, and discerning credible sources. These skills are particularly important in an era where concerns about the prevalence and spread of false information and social media manipulation are rampant (Ruffo et al., 2023). Furthermore, merely familiarizing students with technology is insufficient; they need structured learning opportunities to engage thoughtfully and responsibly with digital content and tools (Ng, 2012b). Digital literacy skills are also critical for navigating e-learning systems, which are essential in higher education and increasingly so in formal K–12 education (Mohammadyari & Singh, 2015; Wang et al., 2023).

This paper addresses the gaps in existing digital literacy frameworks and emphasizes the need for a more contemporary approach. Digital literacy today should encompass more than basic technical skills; it should involve the development of critical thinking skills, the ethical use of digital tools for communication and collaboration, and the creative application of digital tools to generate content. Moreover, current frameworks often lack clarity on how to operationalize and assess these essential skills in students. This paper aims to address these gaps by proposing a definition and framework for measuring and assessing digital literacy that identifies a range of subskills and skill indicators reflecting high school students' digital skill development in the modern digital landscape. We focus on students at the high school level, given the need to prepare learners to use digital information technologies in K–12 (Hobbs, 2017) and postsecondary settings (Spante et al., 2018). Among this age group in particular, comprehensive digital literacy assessments are crucial for shaping educational policies and practices to better prepare students for future challenges in their careers and personal lives (OECD, 2021). Although this work is developed to focus on high school learners, we believe it may provide a model to inform the development of digital literacy frameworks and assessments for earlier grade levels.

Intersections and Distinctions Between Digital Literacy and Other Constructs

As a broad and multifaceted construct, digital literacy is often associated with other related yet distinct constructs, such as computer literacy, media literacy, information literacy, and AI literacy. Each of these constructs shares a connection with digital literacy, but they differ in

focus and scope. For instance, computer literacy primarily focuses on technical proficiency, whereas digital literacy tends to encompass a broader set of higher-order skills, such as the ability to use digital tools and effectively engage with digital information (Hoffman & Blake, 2003). While media literacy and information literacy typically emphasize evaluating information from various sources without a strong focus on the tools used to access source information (Koltay, 2011), digital literacy requires skills for navigating digital contexts, such as practicing online safety and communicating and collaborating effectively in digital environments (Leaning, 2019; Ng, 2012a, 2012b; van Laar et al., 2017). Finally, the recent rise of generative AI technologies has introduced AI literacy as a new and emerging construct, which is focused on equipping individuals with the skills necessary to engage with AI-driven tools responsibly and effectively (Almatrafi et al., 2024; Long & Magerko, 2020). Some have proposed that AI literacy may be considered as a subset of digital literacy (Sparks et al., 2024).

Review of Existing Digital Literacy Definitions and Frameworks

Although there are many digital literacy frameworks (see UNESCO, n.d.), there is currently no consensus on the definition of digital literacy as various frameworks conceptualize it differently, depending on the framework's focus and context. This lack of consensus also reflects the evolving nature of digital tools and how they are used. To better understand how digital literacy is defined and operationalized, we reviewed a range of influential definitions and frameworks of digital literacy that have had an impact in the field (e.g., DQ Institute, 2024; International Society for Technology in Education [ISTE], 2024b; Ng, 2012a; OECD, 2018; Wedlake et al., 2019), as well as several states' Portrait of a Graduate initiatives that include digital literacy as an essential skill. We identified existing frameworks from a selective review of the literature sourced from discussions with experts and through internet database searches. Through this review, we identified commonalities and gaps in defining digital literacy, establishing a foundation for developing a more comprehensive and contemporary digital literacy framework that reflects the skills required in today's rapidly changing digital landscape.

Across the reviewed definitions of digital literacy, many emphasized evaluating online information and the ethical and responsible use of digital tools (e.g., DQ Institute, 2024; Greene et al., 2014; Ng, 2012a; Park, 2013). Some of these definitions also highlight the need for social and cultural awareness in digital interactions, online safety, digital citizenship, and effective collaboration and communication (e.g., Law et al., 2018; List, 2019; Meyers et al., 2013; Ng,

2012a, 2012b; van Laar et al., 2017). These emphases point to a broad conceptualization of digital literacy, extending beyond technical proficiency and understanding how digital tools facilitate knowledge and content creation (List, 2019; van Laar et al., 2017).

Earlier conceptualizations of digital literacy generally emphasize that it includes the ability to effectively use digital tools for various tasks (e.g., DQ Institute, 2024; Google Applied Digital Skills, n.d.; Greene et al., 2014; ITU & ILO, 2017; Mohammadyari & Singh, 2015; Park, 2013), to critically evaluate online information (e.g., DQ Institute, 2024; Eshet-Alkalai, 2004; Greene et al., 2014; Ng, 2012a), to behave ethically and responsibly online (e.g., DQ Institute, 2024; ISTE, 2024b; Park, 2013; van Laar et al., 2017), to communicate effectively in digital environments (e.g., Mozilla Foundation's Web Literacy 2.0 [Chung et al., 2017]; DQ Institute, 2024; Law et al., 2018), and to demonstrate social and cultural awareness in web-based interactions (e.g., Meyers et al., 2013; van Laar et al., 2017). Social and cultural awareness may be reflected in behaviors that provide evidence of online safety, digital citizenship, effective communication, and collaboration in digital environments (Law et al., 2018; List, 2019; Ng, 2012a, 2012b; van Laar et al., 2017).

International initiatives also highlight key digital literacy competencies within global contexts (see Law et al., 2018). For example, the framework for the Programme for International Student Assessment (PISA) includes digital literacy within its information and communication technology (ICT) skills assessments, focusing on competencies like information and data management, communication, digital content creation, and problem-solving in digital contexts (OECD, 2018). Similarly, the Global Standard on Digital Literacy, Digital Skills, and Digital Readiness (DQ Institute, 2024) encompasses eight critical areas reflecting the skills involved in engaging with digital technologies (use, identity, safety, security, emotional intelligence, literacy, communication, and rights) across four dimensions (connectivity, citizenship, creativity, and competitiveness). Additionally, the European Union's DigComp 2.2 framework (Vuorikari et al., 2022) defines five key areas of digital competence: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving.

Despite these shared elements, there are notable gaps in the existing definitions and frameworks. One major gap is the lack of focus on the ability to create digital content and engage in creative problem-solving using digital tools, both of which are crucial in today's digital environments (Mohammadyari & Singh, 2015). Given the active roles of learners in producing

multimedia content, creating digital art, or developing apps, students should be empowered not only to passively consume information, but also to be active creators and innovators in the digital space. Another major gap in digital literacy is in assessments, many of which focus on measuring basic digital proficiency rather than the higher-order skills needed for critical evaluation or creativity in digital environments (Law et al., 2018). Importantly, most existing definitions and resources to support digital literacy are developed for adults (e.g., DigComp2.2 [Vuorikari et al., 2022]; Essential Digital Skills Framework, [U.K. Department of Education, 2019]; International Computer Driving License, 2024; NorthStar Digital Literacy, 2024) or educators (e.g., ISTE, 2024a; GFC Global, n.d.) rather than for K–12 students. Websites such as Google's Applied Digital Skills (Google, n.d.-a) and Be Internet Awesome (Google, n.d.-b), as well as the Microsoft Learn Student Hub (2024) provide valuable resources to gain basic digital skills, but often such resources focus specifically on technical competencies required to use certain digital tools rather than fostering critical engagement with digital content. The Goodwill Community Foundation Teachers Guide (GFC Global, n.d.) is designed to support educators in teaching foundational digital skills but lacks an emphasis on digital literacy's broader aspects, like ethical behaviors and online collaboration.

To expand the review with K–12 students in mind, we gathered and reviewed high school expectations for digital literacy (and related skills) from existing states' initiatives (e.g., Indiana Department of Education, 2020; Nevada Department of Education, 2021; Utah State Board of Education, 2021; Washington Office of Superintendent of Public Instruction, 2018). We note that the adoption and revision of statewide competency frameworks is ongoing and expected to continue to spread to new states in coming years (see Truong, 2019). Through this review, we identified state competency frameworks that mentioned digital literacy or related skills involving the use of digital information technologies. We noted several common themes, including the emphasis on a broad set of core digital literacy competencies, which appeared to focus on critical and responsible online behaviors. However, a shared challenge is the need for more clearly defined assessment methods and clearer pathways for operationalizing these competencies in classroom instruction.

The gaps we identified highlight the need for a comprehensive digital literacy framework tailored to the needs of K–12 students, extending beyond technical proficiency and emphasizing higher-order skills, such as critical evaluation of information, creative digital content creation,

and ethical online behaviors. In light of the emphasis of the frameworks on preparing students with competencies necessary for success as they are exiting K–12 institutions, it may be sensible to begin developing such a framework for high school learners, in particular, and to adapt backward to meet the needs of younger learners. Such a framework should ensure that students are well equipped to navigate and contribute to today's increasingly complex digital environments. To address the challenges of operationalizing digital literacy in assessments and instruction, a new framework should provide detailed descriptions of skill indicators to help break down each digital literacy component into observable and measurable behaviors.

A Definition and Framework for Digital Literacy

During the process of reviewing relevant literature and frameworks, we used a design pattern document (M. Liu & Haertel, 2011), which provides an approach for defining complex constructs according to an evidence-centered design approach (Mislevy et al., 2009). The design pattern template that guided our work included sections that prompted a literature-based summary of the construct of digital literacy, a rationale of its measurement, expectations of the focal population (i.e., high school learners in the United States), important dimensions (i.e., subskills), and observable indicators (i.e., subskill indicators) reflecting the construct, along with additional information such as related yet distinct constructs, contextual factors likely to influence how the skill would be expressed, and potential connections to K–12 disciplinary standards. The synthesis of major skills frameworks (see Table A1) and states' initiatives identified through the review revealed several distinct elements of digital literacy skills, including one's ability to evaluate information presented online, collaborate and communicate online, and engage online in a socially responsible and ethical manner. Based on this review, we define digital literacy in high school educational settings, while remaining applicable to other educational levels and societal contexts as follows:

> Digital literacy refers to a set of knowledge, skills, and attitudes necessary to use digital technologies and tools in a productive and responsible way across social, academic, and professional settings.

Building on the review, we then sought to develop a framework for identifying features that may be observed as students demonstrate digital literacy. For more information about our process for developing this framework, see Table A2. Based on the proposed definition of digital

literacy, we recognized four core subskills essential for navigating the digital world (*DL.1*, *DL.2*, *DL.3*, and *DL.4*; see Table 1).

Table 1. Digital Literacy Skills Framework Showing Subskills and Skill Indicators

Subskill	Skill indicators
DL.1: Uses digital tools to access, manage, and understand information	*DL1.1:* Digital Tool Use and Navigation: Uses a variety of digital tools with specific intent and purpose, navigates efficiently through non-linear digital texts, and problem-solves or seeks help when facing technical challenges.
	DL1.2: Understanding and Interpretation of Digital Information: Understands and uses information from various digital sources in multiple formats, demonstrates appropriate interpretation of information conveyed in a digital medium, and integrates divergent thinking into actionable knowledge, as appropriate.
	DL1.3: Criticism and Evaluation of Digital Information: Is critical of the information encountered when online, exhibits discernment in the reliability and credibility of online information, recognizes that digital content is created with specific purposes and intent, demonstrates strategies for assessing the veracity of digital information, and analyzes and evaluates online information to reasonably detect bias, and understand author and audience text purpose.
DL.2: Uses digital tools to communicate and collaborate	*DL2.1:* Digital Multimedia Communication: Uses, understands, and evaluates multimedia content, demonstrates a grasp of how various techniques can convey meaning in media, uses a variety of media to present information for specific purpose, and reasonably applies knowledge of appropriate attribution, citation, or licensing.
	DL2.2: Digital and Internet-enabled Collaboration: Uses digital Internet-enabled tools to engage, collaborate, and communicate interactively and asynchronously with various agents, audiences, and peers, using appropriate conventions of communication and toward a shared understanding and purpose.
DL.3: Uses digital tools to create content	*DL3.1:* Digital Design and Conceptualization: Creates and expresses digital content and knowledge using various symbols, tools, and methods.
	DL3.2: Digital Curation with Awareness of the User: Meets the needs of the intended audience or users of digital media and ensures a seamless and secure user experience with digital content.
DL.4: Exercises digital citizenship for constructive and responsible social action	*DL4.1:* Digital Ethics and Responsibility: Follows ethical and legal norms of digital technologies and materials and is aware of the possible consequences of violating them.
	DL4.2: Digital Citizenship and Social Inclusion: Critically evaluates and uses digital information and data, understands the social and multicultural aspects of digital media and technologies, and uses them responsibly to support active citizenship and social inclusion.
	DL4.3: Digital Well-Being and Balance: Understands and manages the impact of technology use on health, work productivity, well-being, and lifestyles, and balances curiosity with skepticism when evaluating new and emerging technologies.

The first subskill (*DL.1*) involves using digital tools to access, manage, and understand information, emphasizing efficient navigation, interpretation, and critical evaluation of digital content. Drawing from models like DigComp 2.2 (Vuorikari et al., 2022) and Mozilla's Web Literacy 2.0 (Chung et al., 2017) frameworks, this subskill was seen as crucial for helping students identify misinformation and develop a more discerning digital mindset.

The second subskill (*DL.2*) focuses on using digital tools for communication and collaboration, highlighting multimedia communication as well as internet and digital tool-enabled collaboration with appropriate conventions. This subskill helps students communicate clearly while also working effectively and respectfully in teams (synchronously or asynchronously) through engaging with diverse perspectives in digital environments, which supports students to contribute creatively in online or digital settings (e.g., DQ Institute, 2024; van Laar et al., 2017).

The third subskill (*DL.3*) focuses on creating digital content, involving digital design, conceptualization, and curating content to meet user needs. This subskill intentionally shifts away from a predominantly consumer-based model of digital literacy toward one that stresses content creation and active participation in digital environments, which encourages students to move beyond passive interactions with digital tools and engage actively and creatively in knowledge production and problem-solving (e.g., Law et al., 2018).

Lastly, the fourth subskill (*DL.4*) pertains to digital citizenship, emphasizing ethical behavior, social inclusion, and maintaining well-being in digital contexts. Because online environments often present risks related to privacy, safety, and ethical decision-making for high school students, this subskill is essential for students to navigate online spaces responsibly and protect themselves and their peers from intentional or unintentional harm (e.g., DQ Institute, 2024).

We recognize that more than one subskill may be necessary when performing activities in complex digital environments. For example, to create a digital multimedia project on a topic related to environmental issues, a student may use digital tools to access and discern reliable sources of information (*DL.1*). To present their findings, they may develop a script synthesizing the key insights (*DL.2*) and use video and audio tools to record and share content as episodes of a podcast (*DL.3*), encouraging listeners to reflect on their environmental impact and consider small behavioral changes that could minimize environmental harm (*DL.4*).

In addition to defining digital literacy, we developed subskills and skill indicators for high school students, which may guide curriculum and assessment resources to support students' development of digital literacy. Skill indicators provide specific behaviors under each subskill; for example, using digital tools to create content (*DL.3*) involves specific behaviors, such as designing and conceptualizing content using a variety of tools (*DL3.1*) and creating content with a specific audience in mind (*DL3.2*).

Considerations for Assessing Digital Literacy

Transitioning from understanding what constitutes digital literacy to assessing this multifaceted skill brings several challenges and considerations to light. Assessments play a critical role in competency-based approaches, emphasizing tailored and student-centered learning (Evans et al., 2020). In supporting students' development of digital literacy, assessments need to do more than just measure proficiency; they should also provide essential insights that help students and educators identify current skill levels and set clear and personalized goals for advancing those skills (O. L. Liu et al., 2023). Capturing the full range of students' digital literacy—both in the classroom and in their out-of-school digital activities—requires careful attention to several important considerations. In the paragraphs that follow, we focus on the following key assessment considerations: (a) alignment with instructional and learning goals; (b) authenticity and adaptability of the assessment in a rapidly evolving digital landscape; (c) implications of the assessment design with respect to its psychometric qualities; and (d) considerations for ensuring accessibility, fairness, and equity resulting from the assessment. We then provide some examples of different contexts in which assessments of digital literacy could be implemented to more comprehensively capture a broader range of relevant skills.

First, digital literacy assessments should be closely aligned with instructional goals and the specific learning outcomes that students are expected to meet (e.g., Care et al., 2018). Such assessments can serve as a meaningful tool to give educators the insights they need to provide timely and constructive feedback to support student learning (Adarkwah, 2021; Wisniewski et al., 2020). For example, if the instruction focuses on teaching students how to evaluate the credibility of online sources, the assessments should provide opportunities for students to apply this skill in a real-world context, such as having students research environmental issues and analyze the credibility of various online articles or social media posts. By assessing how well students navigate actual digital platforms (e.g., which sources they explore), evaluate

information (e.g., which sources they think are credible by citing specific evidence), and avoid trusting or sharing misinformation, teachers can gain valuable insights into students' performance in relation to specific subskills (e.g., *DL.1*), and apply those insights to provide feedback and tailor lessons to better support students' progress.

Second, assessments of digital literacy should be designed to mirror authentic real-world tasks while remaining flexible to adapt to the rapid pace of technological change. Authentic tasks may either involve scenarios likely to be familiar to students or elicit evidence of students' skills in a manner that mimics real-world interactions (Darling-Hammond et al., 2010). For example, an authentic, performance-based assessment might prompt students to conduct a simulated cybersecurity audit of a company's data system using online tools to identify potential security vulnerabilities and propose solutions. The same assessment could be updated to include the evaluation of AI-based security systems or ethical considerations surrounding data privacy in social media platforms.

Third, digital literacy assessments should be designed with a deep theoretical connection to the construct to better ensure validity in measuring students' current skills, which provides interpretable and actionable insights to inform teaching (Bennett, 2011). A high-quality digital literacy assessment should be comprehensive, providing strong evidence of validity; reliably capture students' competencies across a range of essential subskills, such as the critical evaluation of digital content, communication and collaboration in digital environments, content creation, and ethical online behavior; and ultimately be informed by standards for educational and psychological testing (see American Educational Research Association et al., 2014).

Fourth, digital literacy assessments should be designed to be accessible, fair, and equitable. Assessments may be designed to appropriately engage students from diverse backgrounds or who have varying levels of access to digital resources and technology integration in the classroom (e.g., Aguilar, 2020; Graves et al., 2021; Warschauer et al., 2004). Given equity concerns related to digital and internet access, the design of assessments should consider students with limited digital access or different learning needs to ensure the assessment is fair and can be used to document evidence of students' digital literacy skills, rather than prior exposure to a certain technology. Designing assessments with this consideration in mind may help to ensure that the assessments produce consistent, fair, and equitable results across diverse student populations.

Assessment Contexts

Recognizing that skill development occurs both inside and outside the classroom, it is important to understand how these learning experiences are interrelated to foster students' digital skill development (Lai et al., 2013). To illustrate the four key considerations for assessing digital literacy in high school students, we use in-school and out-of-school assessments as concrete examples to show how these principles apply in both settings. In-school assessments occur within a formal educational setting, where evaluating student digital literacy is often embedded in specific assignments, such as projects or essays. For example, high school students writing an argumentative essay on the impact of environmental issues as part of a science class could be evaluated on their ability to use digital tools when researching, evaluating sources, and synthesizing information into a coherent argument (see Table 2). This assessment aligns with the instructional goals of developing students' scientific argumentation and engaging them in relevant digital literacy skills (i.e., *DL.1* and *DL.4*). The task is authentic because it involves real-world phenomena and can be adapted regarding what digital research tools are used as technology evolves. The essay could be scored using a rubric aligned with the digital literacy framework to ensure its validity and reliability. Finally, the assessment could be adapted to a range of digital and assistive tools to offer multiple ways for students to demonstrate mastery.

Beyond these examples of formal in-school activities that are directly tied to curricula, out-of-school learning and assessment could support students' development of digital literacy in less structured, informal, and experiential contexts (e.g., internship experiences, community-based activities). For example, in an internship setting, high school students could collaborate with other interns to create a digital guide for employees about an important policy change (see Table 2). This activity demonstrates how digital literacy skills develop in practical out-of-school settings, while also aligning with the goal of preparing students for the workforce, given that many professions require digital literacy skills related to communication, collaboration, and ethical content creation. The activity is also authentic and adaptable, as it allows students to use various digital tools to collaborate or manage content, depending on licenses and digital equipment available in the workplace. A mentor's evaluation could be based on the digital literacy framework when providing an end-of-internship certificate or evaluation. The internship company may provide necessary access to required digital devices, licensed digital tools for

collaboration, or any assistive tools so that all interns could complete their internship project, thus addressing concerns related to fairness and accessibility.

Table 2. Examples of In-School and Out-of-School Assessment Tasks of Digital Literacy Subskills

Assessment type	Task description	Context	Subskills assessed
In-school assessment	As part of an in-class assignment, a student drafts an argumentative essay on the impact of an environmental issue, and in the process, collects online sources, creates an annotated bibliography, and critically evaluates scientific evidence.	Science class: Collecting and evaluating scientific evidence of the environmental issue and the responsibility of humans in reducing carbon emissions; developing arguments about whether current climate policies are effective and suggesting improvements based on scientific data.	Digital tool use and navigation (*DL.1.1*) Understanding and interpreting digital information (*DL.1.2*) Criticism and evaluation of digital information (*DL.1.3*) Digital ethics and responsibility (*DL.4.1*)
Out-of-school assessment	As part of an internship, a student collaborates with other interns virtually to create a frequently asked questions (FAQ) guide regarding an impending policy change for company employees through researching the policy and designing a visually appealing and user-friendly guide that is easy to navigate.	Internship setting: Helping the organization effectively communicate an important internal policy change to all employers.	Digital multimedia communication (*DL.2.1*) Digital and internet-enabled collaboration (*DL.2.2*) Digital design and conceptualization (*DL.3.1*) Digital curation with awareness of the user (*DL.3.2*)

Integrating the Assessment into Educational Systems

The contexts and educational systems where digital literacy assessments are incorporated also need to be carefully considered in the process of enacting such assessments. Several states have already identified digital literacy and related skills as critical for high school graduates (e.g., using technology and tools, finding credible sources, engaging as a digital citizen [see Indiana Department of Education, 2020; Nevada Department of Education, 2021; Utah State Board of Education, 2021; Washington Office of Superintendent of Public Instruction, 2018]). Such sets of competencies may be referred to as a Portrait/Profile of a Graduate (or Learner), which outline a set of critical competencies associated with success in post-secondary academic, professional, and interpersonal contexts (Atwell & Tucker, 2024). For instance, Utah's Portrait of

a Graduate ("Portrait") details digital literacy competencies for each grade level from pre-K to Grade 12, emphasizing skills like evaluating the impact of digital practices, investigating source credibility, using technology purposefully, communicating across diverse audiences and mediums, and collaborating digitally (Utah State Board of Education, 2021). Utah's Portrait shares similarities with the presented framework. For example, Utah's Portrait for Grades 9–12 includes evaluating how digital practices impact rights, responsibilities, and opportunities, aligning with *DL.4* (digital citizenship for constructive and responsible social action). This alignment includes *DL.4.1* (digital ethics and responsibility) and *DL.4.2* (digital citizenship and social inclusion), which focus on ethical digital interactions, understanding social and multicultural aspects of digital media, and using technology to support active citizenship and inclusion.

The integration of digital literacy assessments in existing educational systems may require long-term changes within a broader ecosystem of supports to be most effective. According to the Skills for the Future (SFF) Initiative, a collaborative effort between ETS and the Carnegie Foundation, the assessment of complex skills is an integral component of competency-based education and therefore should be viewed within a broader ecosystem (O. L. Liu et al., 2023). The SFF initiative proposes a comprehensive strategy for skill identification and demonstration. Such an approach may serve as the basis for developing a skills assessment infrastructure with the potential to have a transformative impact in assisting teachers in identifying key digital literacy skills and supporting students in developing these skills.

Future Directions and Considerations

In the previous sections, we provided a review of existing efforts to define digital literacy skills, proposed a comprehensive definition and framework of digital literacy for use in Grades 9–12, and offered considerations for developing and integrating assessments of digital literacy within in-school and out-of-school contexts. Building on this work, we present several implications for future work to support the assessment of digital literacy. We believe assessments of digital literacy should be sufficiently comprehensive in their coverage of digital literacy skills, address the rapid evolution of technology, leverage personalization to foster students' engagement and agency in providing evidence of skills, strive toward more equitable access to technology and information, and capture cross-cultural perspectives on digital literacy. With regard to assessment design, advanced technologies could be used to enrich assessment

experiences (Kyllonen et al., 2024), for example, by incorporating AI to enhance features of interactivity and personalization in assessment (Arslan et al., 2024). At the same time, access to technology and socioeconomic factors needs to be further considered when designing assessments of digital literacy because of their influence on digital literacy skill development opportunities (Lythreatis et al., 2022), thus posing challenges when assessing the construct in a fair and equitable manner. Finally, international initiatives highlight digital literacy's importance across the world (e.g., OECD, 2018), and such perspectives could further inform the development of comprehensive assessment frameworks that consider cultural and contextual diversity.

Given the important and dynamic nature of digital technologies and evolving understandings of digital literacy, continuous revision of assessment frameworks—including the framework proposed here—is essential. Particularly for such a dynamic and situated skill as digital literacy, an iterative process for operationalizing the construct is needed to ensure better alignment with evolving digital and social environments, thus allowing for more useful measures of skills associated with success in a contemporary digital age. Collaboration among educators, interest holders, industry representatives, policymakers, and assessment experts is therefore critical for creating assessments of digital literacy that meet evolving learner and societal needs.

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Appendix

Table A1. Existing Digital Literacy Skill Frameworks Reviewed

Framework	Focus/definition of digital literacy	Citation
America Succeeds: Durable Skills Advantage Framework	This framework describes "durable skills," which are skills important across the lifespan, especially when seeking employment. However, they do not view digital literacy as a Durable skill, but rather "The best preparation in the face of uncertainty and rapid innovation is a combination of academics, digital literacy, and Durable Skills" (p. 7, Cole et al., 2021). Thus, this framework recognizes the importance of digital literacy, but it is not a part of their Durable Skills framework.	Cole et al. (2021)
Global Standard on Digital Literacy, Digital Skills, and Digital Readiness	The DQ (digital intelligence) framework is one of the most comprehensive international digital literacy frameworks. The framework has eight areas (digital use, identity, safety, security, emotional intelligence, literacy, communication, and rights) and four levels (connectivity, citizenship, creativity, and competitiveness) for a total of 32 competencies.	(DQ Institute, 2024)
International Society for Technology in Education (ISTE)	The ISTE teacher and student competency frameworks focus on digital citizenship as one important skill for students. It is composed of three subskills: Digital footprint (e.g., making ethical decisions), online interactions (e.g., showing empathy), safeguard well-being (e.g., reducing time spent online), and digital privacy (e.g., security).	ISTE (2024a, 2024b)
McKinsey Skills Framework	The framework identifies 56 foundational skills and attitudes across four categories (cognitive, interpersonal, self-leadership, digital fluency; Dondi et al., 2021). Digital fluency, which is relevant to digital literacy, contains 3 skills with 3-4 subskills each: digital fluency and citizenship (digital literacy, digital learning, digital collaboration, digital ethics), software use and development (programming literacy, data analysis and statistics, computational and algorithmic thinking), and understanding digital systems (data literacy, smart systems, cybersecurity literacy, and tech translation and enablement). Digital literacy is a specific subskill of digital fluency and citizenship in this framework. It is defined as "The ability to handle digital data, use popular software, access digital services, and interact with AI" (Dondi et al., 2021, p. 14). The desired proficiency level is as follows "Individuals regularly use the internet, access services digitally, use popular software, and understand that online activity creates data that others can use" (Dondi et al., 2021, p. 14).	Dondi et al. (2021)

Framework	Focus/definition of digital literacy	Citation
Mozilla Web Literacy	The Mozilla Web Literacy Framework outlines essential skills for navigating and contributing to the web, emphasizing the importance of digital literacy as a foundational skill akin to reading, writing, and arithmetic. The framework is designed to support diverse audiences by enhancing their web literacy through four key areas: "Read," which focuses on exploring and evaluating web content; "Write," which encompasses creating and sharing digital content; "Participate," which involves engaging with online communities and understanding security; and "21C Skills," which highlight critical thinking, collaboration, and creativity. Developed through extensive research and community input, the framework aims to foster good web citizenship and leadership, ensuring that individuals can effectively leverage the web as an open resource for personal and professional growth.	Chung et al. (2017)
OECD 2030 Learning Compass	The OECD 2030 Learning Compass outlines knowledge, skills, attitudes, and values for 2030 that include cognitive foundations (literacy and numeracy; digital literacy skills can build upon these foundations), health foundations (physical and mental health and well-being), and social foundations (morals and ethics). Digital literacy is included among the core knowledge, skills, attitudes, and values as an important cognitive foundation and defined as, “Digital literacy relies on the same fundamental abilities as traditional literacy; but digital literacy is applied in digital contexts and draws on new digital tools and competencies” (OECD, 2019, p. 5).	OECD 2030 (2019)
Partnership for 21st Century Skills Framework	Although this framework does not mention digital literacy directly, they do note digital literacy-related skills under the skills of ICT (Information, Communications and Technology) literacy. Specifically, they note using technology to “research, organize, evaluate and communicate information,” using “digital technologies (computers, smart phones, etc.), communication/networking tools and social networks appropriately to access, manage, integrate, evaluate and create information to successfully function in a knowledge economy,” and understand “ethical/legal issues surrounding the access and use of information technologies” (Partnership for 21st Century Skills Framework, 2007, p. 5–6).	Partnership for 21st Century Skills Framework (2007)
United Nations Educational, Scientific and Cultural Organization (UNESCO)	This framework regards digital literacy as composed of five competence areas, each with 3–6 competences: Information and data literacy (e.g., browsing and filtering information), communication and collaboration (e.g., interacting online), digital content creation (e.g., developing content), safety (e.g., protecting personal information), and problem-solving (e.g., solving technical problems).	Law et al. (2018)
XQ Framework	The XQ framework does not mention digital literacy specifically, however, it does note the following subskills under the Communicating and Receiving Ideas skill (XQ Institute, 2024): “Making Meaning: Interpret information from many sources (FL.ID.1), ” “Persuasive Communication: Inform and persuade others (FL.ID.2),” and “Critical Dialogue: Make and support arguments (FL.ID.3).” Though these subskills are aligned with information literacy, they are relevant to digital literacy when applied in digital environments.	XQ Institute (2024)

Framework	Focus/definition of digital literacy	Citation
Other Frameworks	Ng et al. (2012a) describe three dimensions of digital literacy: technical (e.g., using technology, troubleshooting), cognitive (e.g., searching and evaluating information), and social-emotional (e.g., responsible online behavior).	Ng (2012a)
	van Laar et al. (2017) conducted a systematic literature review of 21st-century digital skills. They describe 21st-century digital skills as having seven dimensions: technical, information management, communication, collaboration, creativity, critical thinking, and problem-solving.	van Laar et al. (2017)
	Eshet-Alkalai (2004) proposes a framework of digital literacy that is composed of five different types of literacy that encompass cognitive skills used in digital environments: photo-visual, reproduction, branching, information, and socioemotional.	Eshet-Alkalai (2004)

Table A2. Stages for Conceptualizing the Digital Literacy Skills Definition and Framework

Stage	Description
1. Review of Existing Literature and Frameworks	• Explored existing knowledge to create a strong digital literacy skills framework. • Gathered theoretical and empirical research, studied digital literacy literature, and examined established frameworks. • Reviewed competency definitions and frameworks used by various states (e.g., Utah State Board of Education, 2024) to identify similarities between definitions the skill of digital literacy and to consider potential relevant behavioral indicators.
2. Synthesize and Draft a Definition	• Documented relevant information from the literature search, frameworks, and common themes using a design pattern document (M. Liu & Haertel, 2011). Such information included a summary of the literature and existing frameworks relevant to the construct, a rationale for its measurement, expectations for focal population, focal subskills, among other types of information. • Refined understanding and definition of digital literacy skills through continuous iteration.
3. Identify Relevant Subskills and Skill Indicators	• Informed by the prior stages, drafted subskills in an effort to document observable features of digital literacy skill demonstrations likely to enable effective measurement and assessment. Distinctive dimensions of the skill of digital literacy (i.e., subskills) were further defined. Within each of the unique dimensions, observable feature (i.e., subskill indicators) were further identified.
4. Expert Evaluation	• Collaborated with assessment experts with expertise in K-12 and high education, and workforce training to review and evaluate the definition and framework for theoretical relevance, clarity, and appropriateness given the focal population. In particular, this process involved individually reviewing definitions and frameworks for each digital literacy skills with other related skills (e.g., communication, critical thinking, perseverance) to identify features of skill definitions and frameworks that overlapped or appeared similar across different skills.
5. Refine and Finalize	• Collaboratively discussed the overlapping features of skill definitions and frameworks. • Refined subskills and indicators through discussions and consensus-building to ensure greater precision and minimal overlap. • Minimized redundancy and ensured clarity. • Finalized the set of distinct subskills and indicators that capture effective digital literacy.
6. Develop Skill Progress Levels	• Draft behavioral indicators reflecting evidence of digital literacy skills across a continuum of proficiency. • Evaluate the consistency of the language used to describe the advancement across progress levels in the skills progression framework.
7. Identify Task Examples for Skill Demonstration	• Generate multiple examples of in-school and out-of-school activities in which learners may demonstrate evidence of the skill of digital literacy.

Note. Stages 6 and 7 are under development. Adapted from Ober et al. (2025).

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