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Teaching and Learning in a Digital World

Digital Literacies for Disciplinary Learning

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In this chapter, we approach digital and disciplinary literacies as intricately linked concepts that, when coupled together, offer powerful opportunities to harness the learning potential of the Internet to engage learners across disciplines (Goss, Castek, & Manderino, 2016; Manderino & Castek, 2016; Castek & Manderino, 2017). We are both teachers and researchers, each with a strong commitment to improving instructional practice, teacher development, digital inclusion, and student engagement. Jill researches online reading, digital literacies and inquiry, and the use of digital texts and tools to support learning in science, technology, engineering, and mathematics (STEM). Michael studies disciplinary literacies in digital contexts in history and English language arts and examines the use of multimodal texts for disciplinary learning. This chapter unites our complementary perspectives across disciplinary fields as well as across K–12 and adult education in formal and informal settings.

Over the course of a 2-year period, we have been discussing digital and disciplinary learning with our colleagues in schools and universities. These discussions revealed three important potentials for linking disciplinary and digital literacies. These three potentials recognize that teaching and learning with digital technologies require us to think differently about classroom organization. They also introduce synergistic practices centered around teaching literacies in ways that cut across disciplinary boundaries. The three potentials we discuss in this chapter are (1) bidirectional expertise, (2) democratizing knowledge production, and

(3) expanded inquiry approaches that include both problem posing and problem solving.

Additionally, we describe a framework of organizing principles that dovetails with these potentials. The framework addresses three organizing principles for planning classroom instruction: (1) accessing and evaluating information, (2) using and representing information, and (3) producing and exchanging information. The chapter focuses on the potential for transforming instruction when digital and disciplinary learning are tied together.

Learning in a Digital World

Digital texts and tools have proliferated into every facet of our lives in the past few decades. Digital devices and networks have affected the ways we share ideas and communicate. In a recent survey, 95% of teens reported possessing a smartphone, with 45% reporting they are online constantly and another 44% reporting being online several times per day (Anderson & Jiang, 2018). Unfettered access to online resources and collaborative platforms creates opportunities to use and produce a vast range of materials that can be shared, revised, and remixed. These digital potentials allow us to connect with individuals and groups both locally and globally, and to contribute to an ever-expanding base of knowledge.

The Internet, online information, and networked communication tools mediate the ways we learn, especially in the disciplines, but the tools to develop knowledge have traditionally been implemented offline and face-to-face. However, the availability of digital texts and tools widens and amplifies opportunities to develop conceptual knowledge in the disciplines. In today's world, digital devices are increasingly used for accessing and sharing information, creating representations of conceptual thinking, and encouraging dialogic interchanges. Internet use and global networking that address these purposes unleash vast potential and a multitude of real-world contexts in which learners may engage as critical and agentive citizens.

Digital literacies are multifaceted and multidimensional. They are needed to use digital tools to both consume and produce knowledge. Learners who are digitally literate need to develop flexible mindsets and competencies to make choices, interact, and engage in an open, networked society (Lankshear & Knobel, 2006; Phillips & Manderino, 2015). In addition, digital literacies represent the multitude of ways

people collaborate, create, and communicate using digital texts and tools. Furthermore, they are critical to fully accessing disciplinary learning whether a learner is an expert or novice. As such, the role of disciplinary practices as situated in classrooms has been theorized and researched in terms of habits of practice (Wickens, Manderino, Parker, & Jung, 2015). This research considers the situated nature of learning within a disciplinary community and how participation in such a community impacts an individual's knowledge construction. Habits of practice also recognize the wider range of disciplinary practices, including the distinct habits of thinking within a discipline that are needed to develop deep disciplinary knowledge and understanding.

Classroom and youth practices have driven the need for comprehensive policies regarding literacy and technology in education. School adoption of 1:1 computing has accelerated access to new technologies, but has not necessarily created equity in terms of use, instruction, or assessment. As educators, we can no longer sideline the learning of these essential literacies; doing so leaves digital literacies instruction to chance. Under-resourced communities and students who find themselves on the wrong side of the digital divide may not have regular access to tools, devices, nor have opportunities for contextual practice in using them to advance their learning (Leu, Forzani, & Kennedy, 2015; Leu, Forzani, Rhoads, et al., 2015). For many learners, school is the best place to learn digital literacies in a formal way. However, many schools have not provided such instruction. All students need opportunities and instruction to learn the full range of digital literacies in the disciplines and across the curriculum in order to be fully literate in a digital age.

The Growing Importance of Disciplinary Literacies

Recent scholarship on literacy has focused specifically on how the disciplines (e.g., history, literature, science) shape individuals' ways of knowing, and how those ways of knowing impact an individual's construction of meaning when interacting with domain-specific texts or in domain-specific contexts. For example, the way that an expert reads a science text differs from that of a nonexpert. In other words, readers who are steeped in a discipline such as science possess habits of thinking that support the comprehension of the text. A scientist may approach a text skeptically because she knows that an individual scientific text must be congruent with scientific evidence. The scientist may also adjust her reading

to account for the integrated nature of graphics and text to identify a claim made within the text. Finally, a scientist may use a particular text to inform her construction of a model or to generate a hypothesis for an experiment. Discipline-specific teaching helps learners understand the ways in which disciplinary texts are constructed and encourages them to employ particular practices when learning from such texts.

A historian, on the other hand, likely approaches a text differently. She may look specifically for divergent perspectives and seek to disrupt a particular narrative based on the historical evidence provided. A historian may also consider who wrote the text and the context in which it was written to ascertain the veracity of the account as a credible perspective. Finally, a historian may use a set of resources to construct a written argument about the role of a particular event in history.

The purpose of these two examples—one in science and the other in history—is to show that the goals of the reader and the context/domain in which they are constructed impact how an individual makes meaning from a text. No matter the discipline, however, the development of conceptual knowledge is vital to its disciplinary practice.

Today's classrooms hold the potential to become engaged learning environments in which students are immersed in authentic disciplinary practices. In such an environment, students regularly engage in analysis, think for themselves about the information they collect, and share ideas from different perspectives to make sense of the content they find both online and face-to-face. Disciplinary instruction involves asking questions, constructing meaning from data, generating creative solutions, and reflecting on how to improve these solutions for different contexts; this occurs through inquiries into solving real-world problems that impact learners and their understanding of the world.

Changes to education contexts call for shifting mindsets and embracing literacies as multiple, situated, and social (Gee, 2000; Street, 2003). Designing instruction within a frame of multiple, situated, and social literacies opens up space to address social and textual practices that are central to digital and disciplinary learning. Paying attention to sociocultural aspects of learning (e.g., dialogue and collaboration) in addition to cognitive components (e.g., strategies and processes) opens new possibilities for innovative digital and disciplinary instructional design. As Shanahan, Silvestri, and McVee (2018) suggested, it is critical for students to participate in learning contexts that are reimagined to provide three types of opportunities: (1) they should allow for language-in-use as students work through problem solving with hands-on, minds-on involvement; (2) they should enable the solving of student-identified problems;

and (3) they should incorporate digital documentation as a mediational tool. These practices, when applied in instructional contexts, facilitate students' development of insider discourse, agency, and identity.

Disciplinary literacies that rely solely on print resources are no longer sufficient to fully convey complex and multilayered meanings given that learning in the digital age traverses digital/print, in- and out-of-school, face-to-face, and virtual communication. Full participation in the disciplines cannot be possible without a commitment to understanding digital literacies and their associated practices, and digital literacies are critical to fully accessing the literacies required for disciplinary learning.

Digital Literacies for Disciplinary Learning

Digital literacies are shaped by disciplinary learning. For example, scientific inquiry often includes the construction and testing of a representational model that is driven by scientific principles and concepts (NGSS Lead States, 2013). Examples of scientific models may include representations of the water cycle, cell division, or particle acceleration. Digital tools help learners visualize what they cannot readily see and provide the means to explore these models in a fully immersive way. Virtual reality applications and headsets allow learners to examine digital models from all angles, up close and in the round, as if the object were held in their hands. The construction of three-dimensional (3-D) models of cell division, for example, and the use of interactive digital features within these models, may be more effective at communicating dynamic processes than traditional two-dimensional figures. Moreover, the higher-order thinking processes used to interpret the 3-D models can be more generative and applicable to visualizing related concepts.

Digital literacies also shape the ways that individuals construct and communicate disciplinary knowledge. For example, if a learning goal is to communicate an analysis of a historical event, consideration of the medium is important. One task learners may be assigned is to write a critical interpretation for the teacher. However, digital contexts allow individuals to communicate with a wider audience that includes the public. Digital literacies, and the selection of a particular digital tool or medium, shape the possibilities for that knowledge construction and communication. Decisions to blog or create a digital artifact, and decisions about where to share the representation (e.g., on Twitter or on one's Web page), all impact the audience that the creator intends to engage. No matter how the information is shared, the digital and disciplinary

literacies used to create it are interdependent and central to the learning experience.

Since print resources no longer sufficiently convey the complex and multilayered requirements of disciplinary literacies, it is important to use the wide range of communication tools available in the digital age. For example, disciplinary and digital literacies are necessary to disentangle and critically evaluate online texts, because authorship, credibility, and accuracy can be veiled on the open Web. Similarly, digital literacies are critical to fully accessing the literacies required for disciplinary learning. As a result, we argue that digital and disciplinary literacies should be thought of as inextricably linked rather than as separate areas of focus.

Most disciplinary practices in fields such as science, journalism, engineering, and other careers include digital resources as part of their inquiry. These inquiry processes include gathering information, visualizing data, generating visual representations, and communicating. These practices require both digital and disciplinary literacies to read, write, and express ideas in multiple forms. Linking digital and disciplinary learning uses the Internet's networking and knowledge-building resources toward this end. Likewise, using digital media can help shape learners' understanding of the social and intellectual practices of the discipline.

As the pace of digital innovation accelerates, educators at all levels must make space for instructional practices that build on the synergies between digital and disciplinary learning. To achieve this aim, educators must break through those typically predefined spaces bounded by school and help learners find ways to deepen their involvement with online resources, learning materials, and networks. Some schools and communities have jointly made strides in helping students gain access to the Internet both in and out of school by issuing one laptop, Chromebook, or tablet to each student through 1:1 computing. These programs open new avenues for learners, encouraging them to inquire, connect, and create, by providing everyone, both students and teachers, access to the digital tools for deeper learning within and across disciplines.

Three Potentials Addressed by Interweaving Digital Literacies for Disciplinary Learning

The power of digital texts and tools is clear; however, we argue that this power lies in the form of three potentials for deep learning: bidirectional expertise, democratizing knowledge production, and inquiry approaches that include both problem posing and problem solving.

First, given youth affinity for, and experience with, digital environments, we propose that knowledge production become more bidirectional *between* teacher and student, rather than *from* teacher to student. Second, the purposeful interweaving of digital literacies for disciplinary learning can democratize knowledge production within the disciplines and open new opportunities for inquiry within and across disciplines. Finally, digital literacies for disciplinary learning create opportunities for inquiry that extend beyond traditionally prescribed classroom-controlled inquiry and into inquiry processes that focus on both problem posing and problem solving. These inquiry processes transcend both the physical space of the classroom and the temporal confines of the traditional school day and calendar.

However, simply providing access to digital texts and tools alone does not create opportunities to build political or social consciousness, increase civic engagement, or generate solutions to problems facing communities and the world at large. Developing this kind of consciousness involves instruction around both problem posing and problem solving, and also requires disciplinary understanding—the sort of disciplinary practice that requires educators to think in flexible ways about designing instruction. These three specific potentials can be used to facilitate deep learning and wide knowledge construction. In the sections that follow, we describe and explain these three potentials. The discussion of these three potentials is intended to prompt consideration of shifts in teaching and learning paradigms, and to offer new ways of thinking about engaged learning and instructional approaches for classrooms.

Potential 1: Bidirectional Expertise

The digital world is constantly changing, but a persistent trend is that the digital world is a collaborative world. Learning in the 21st century is marked by greater access to texts in multiple formats, multiple forms of representation, multiple means of knowledge construction, and varied communication vehicles to organize, collaborate, and disseminate knowledge. These realities necessitate new ways of organizing teaching and learning. One promising approach is apprenticeship. This approach emphasizes the role of the teacher in providing demonstrations, engaging students, monitoring their understanding, providing timely support, and ultimately withdrawing that support as students gain independence. However, when applied to disciplinary learning, this model regards the teacher as expert and the student as novice. Studies of digital practice often show youth as digitally proficient (e.g., Barron, Gomez, Martin, &

Pinkard, 2014), suggesting that expert/novice labels only serve to reify, or solidify, learning as didactic. Reimagining apprenticeship models when digital literacies are leveraged for disciplinary learning suggests reinventing collaborative relationships (Greenleaf, Schoenbach, Cziko, & Mueller, 2001) to achieve the goals of both teachers and learners. Learners bring their extensive experiences using digital technologies with them to the classroom, and these experiences, when shared, can be transformative. Distributing knowledge and expertise widely across the learning landscape is beneficial for the whole community, and even more so when it emanates from students' expertise. Benefits include increased relevance, buy-in, and student empowerment. Shifting traditional notions of expert–novice relationships to more bidirectional knowledge exchanges between adults and youth can potentially encourage more collaborative forms of inquiry.

Creating opportunities for youth to demonstrate ways they access, make sense of, and dialogue about online resources repositions students from passive learners into active participants and decision makers about their own learning experiences and outcomes. With this greater agency, however, students need guidance in their evaluation of media sources (Wineburg & McGrew, 2017).

In a media-saturated environment, the need for critical evaluation of sources is just as important as the ability to access sources. Traditionally, teachers are the arbiters of what texts are consumed; therefore, the texts are assumed to be credible. By making use of bidirectional expertise, teachers can also help students develop agency in text selection; teachers and students can co-construct the processes for critically evaluating sources of all kinds.

There are two areas that can become powerful levers for digital literacies engagement in the disciplines: (1) having youth select texts and (2) co-constructing inquiry. First, data from a recent survey of 1,200 English language arts teachers show that in comparison to teachers' responses in a 2013 survey, more teachers are selecting texts based on reading level rather than grade level (Griffith, with Duffett, 2018). This approach is problematic not only in terms of using authentic texts for disciplinary inquiry, but it also reinforces a lack of agency for adolescents in terms of their own selection of texts within their disciplinary inquiry.

Rather than singularly focusing on texts that are perceived to be readable, we argue that the focus should instead be on disciplinary inquiry that is supported by digital texts and tools. It is also the case that when students are active participants in the inquiry, the level of complexity in

texts with which they engage accelerates. As such, when students participate in this process by accessing and evaluating the sources that drive their inquiry themselves, they become a part of disciplinary production.

An example of this type of approach was advanced within a high school English class in which students brought in media texts to analyze with their classmates in a practice called #litanalysis4life (Rainey & Storm, 2017). In this instructional practice, young people bring their unique ways to use and represent information in digital spaces. Images, graphics interchange formats (GIFs), and videos dominate the media landscape. As this researcher–teacher collaboration seeks to apprentice students in disciplinary approaches to inquiry, the students actively engage in the medium that allows them to best share their knowledge construction. In this particular example, the texts that students brought into the classroom were analyzed through multiple interpretive lenses, such as a historical lens, a race lens, and a socioeconomic lens (Rainey & Storm, 2017). The disciplinary practices that are highly valued within the literary community are then brought to bear on the types of texts that are highly valued by students. As evidenced in this example, while there are norms for disciplinary communication, new forms of media are embraced as vehicles for sharing disciplinary knowledge.

In disciplines beyond English language arts, students' experiences with podcasts or video creation can be ideal for creating a medium that allows for broadly sharing disciplinary knowledge construction. The norms and practices of the disciplines can be brought to bear in not only the analysis of student-selected texts but also the production of new texts by students. Such texts allow students to represent and communicate disciplinary knowledge to others in ways that mirror the exchange of ideas in the digital world beyond school. Furthermore, by enabling students to make broad use of social media to connect ideas in networks that are familiar to them (e.g., Twitter, Facebook, Instagram) (Anderson & Jiang, 2018), teachers are able to scaffold students as they decide how best, and where, to share that knowledge with others online.

Potential 2: Democratizing Knowledge Production

Many scholars have argued that digital interactions offer students opportunities to discover multiple ways of knowing the world—including how to participate within and across academic discourse communities—and that providing these spaces is a matter of social justice (Lee & Spratley, 2010; Moje, 2007). All students deserve access to rich, intellectual conversations,

information, and digital literacies instruction that prepare them for college and careers. Such activities are key components of participation in a digital information age, leading to participatory citizenship and personal fulfillment. Moreover, disciplinary communities are enriched through the participation of linguistically and culturally diverse voices.

Multiple text types, various modes of meaning making (New London Group, 1996), and online and offline cognitive practices are all situated in disciplinary contexts. Digital texts and tools used for disciplinary learning should be grounded in social participation that is mediated by both the discipline *and* the learning environment. In other words, digital texts, digital tools, and the disciplinary specific ways to use them in many different learning contexts (e.g., classrooms, outdoors, in fieldwork, and in the community) should all be taken into consideration.

In the broadest sense, the Internet is a participatory culture (Jenkins, 2006), one that is marked by low barriers to entry, in which all members' contributions are valued. In fact, in the digital age, barriers to texts, audiences, production tools, and disciplinary experts are greatly reduced. Theories of multiliteracies, new literacies, and participatory cultures can converge in this setting to offer dynamic potentials for disciplinary learning. However, this potential has gone largely untapped.

The digital world—including social networking spaces and digital texts and tools—can be used to open up spaces for students to participate in discovery that is even more authentic and empowered than ever before, regardless of the discipline. Unfortunately, approaches to disciplinary content in many classrooms fall short of these aims. As the democratization of the Internet opens access to historical and scientific documents for individuals to read and make sense of, learners require a second layer of disciplinary thinking that accounts for a source's digital presence. As educators, we must teach our students to ask questions, such as who wrote this material, for what purpose, what implicit biases are attached to it, whether and to what extent the information is shaped by commercial interests, and whether and to what extent it may be trustworthy, along with other means of interrogating the text.

On the other hand, rich examples of this type of democratization, such as *makerspaces* (collaborative work spaces for making, learning, exploring, and sharing ideas) have occurred inside and outside of school and in afterschool settings, libraries, or other public and private facilities (Phillips, Woodard, & Killian-Lund, 2016; Tucker-Raymond, Gravel, Wagh, & Wilson, 2016). In makerspaces, learners of all ages act as mentors when working with and alongside more and less experienced peers.

Through this process of knowledge sharing, skilled makers apprentice those more novice as part of their projects.

Tucker-Raymond et al. (2016) provided an example of Nakim, a young mentor, who was working on a woodcut design for a book jacket as part of a community makerspace focused on the arts. He had access to expert woodcutters, both in person and through his extended maker online community. As he designed his own woodcut book jacket, he also shared making tips for other learners on his blog. What is unique about this example, as well as this learning space, is that the learners drove the task and products. In the process of engaged learning, learners exchange the tips and lessons learned from mentors with other peers and learners. This circular flow of ideas, practices, and information through digital and nondigital means results in new products and approaches to learning-through-making.

Despite recognized potentials such as those in the previous example (Tucker-Raymond et al., 2016), disciplinary educators have given too little attention to the democratizing potential of digital literacies and have not fully embraced synergies between digital and disciplinary learning. Disciplinary insiders have served as gatekeepers regarding what information is made accessible. In contrast, the Internet makes access to knowledge and the ability to communicate and critique that knowledge within a worldwide forum largely open and free. To capitalize on the open and free Internet, and to problem-solve and communicate solutions, we advocate that such democratizing platforms be used more widely to provide greater access to, and participation in, the disciplines.

Potential 3: Expanded Inquiry Approaches That Link Problem Posing and Problem Solving

Inquiry learning is an engaging way to design instruction, one that links problem posing with problem solving. By foregrounding these constructs in instruction, disciplinary and digital literacies are not simply learning tasks to be mastered, but rather tools that help individuals' attempts to solve intellectual and real-world problems. The confluence of digital and disciplinary literacies for these purposes expands opportunities for learning beyond the walls of secondary schools, postsecondary institutions, and formalized learning spaces.

Inquiry as a stance for learning has long been espoused (e.g., Dewey, 1938). As astrophysicist Neil DeGrasse Tyson (2015) remarked in one of his speeches, people are perpetually engaged in science and are constantly

questioning the world around them. However, school structures have tended to stifle this sort of natural inquiry. While many school tasks focus on teacher-initiated questions (Cazden & Beck, 2003; Wells, 1993), even inquiry-labeled activities are typically designed with prescribed answers in mind. If digital literacies for disciplinary learning are used to leverage bidirectional expertise and capitalize on the democratization of knowledge consumption and production discussed earlier, then inquiry must also be student driven and allow for nonlinear processes to pose and solve social and intellectual problems.

Shanahan et al. (2018) captured the potential of inquiry by using engineering journals in an afterschool club. In this club, students shared their design decisions through multimedia texts in their engineering journals. The journals made use of content-rich vocabulary and provided students with opportunities to represent their inquiry through multimodal artifacts, allowing English language learners to engage in rich disciplinary practices while developing their language skills. Just as with the example on democratizing knowledge production (Potential 2), we see examples of inquiry, design, and apprenticeship in spaces outside the confines of the classroom in this sequence of events.

One key to incorporating digital tools in disciplinary learning is to match disciplinary inquiry goals with a range of digital tools that support those goals. Students then have voice, choice, and agency in their learning. If we aim to invite inquiry learning across disciplines in ways that will benefit those learners who are often the most marginalized in academic contexts, then we must create opportunities for these types of inquiry practices in classrooms. In the next section, we describe a planning framework that can guide teachers who are working to create spaces for teaching digital literacies within disciplinary learning.

Addressing the Three Potentials: An Instructional Framework

We previously introduced three potentials that address instructional practices to link digital literacies and disciplinary learning. The benefits of the three principles can be maximized for designing classroom instruction when they are examined alongside a planning framework. The planning framework we have designed (Castek & Manderino, 2017) suggests ways to organize and embed digital literacies for disciplinary learning into classroom instruction that can make the most of the synergies that

exist between these areas. The framework is not meant to suggest hierarchical steps or linearity. Instead, it introduces multiple points of entry for flexible instructional planning and execution, offering three areas that should be thought about and addressed across extended instructional sequences. Planning instruction in this way provides the means to teach students a range of digital and disciplinary practices, such as how to critically evaluate disciplinary information, ways to examine multiple perspectives using different disciplinary lenses, and suggestions for expressing their interpretation of disciplinary concepts. As shown in Figure 7.1, the three areas of the framework include (1) accessing and evaluating online information, (2) using and representing online information, and (3) producing and exchanging online information.

Accessing and Evaluating Online Information

In today's information-rich digital spaces, it is critically important to determine which resources offer the most knowledgeable perspectives and come from the most reliable sources. Disciplinary learning relies on compiling discipline-specific information that comes from many sources, both online and offline. However, it is not always clear where information or even data found online originates. It is essential that we teach students

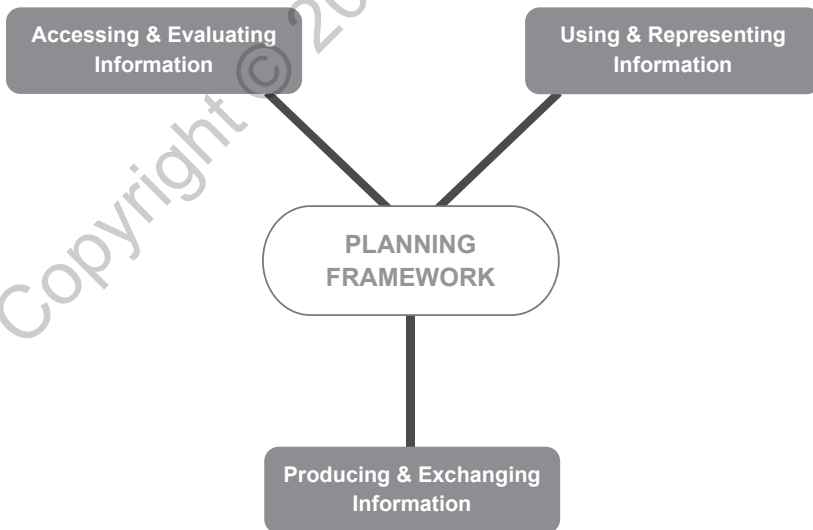


FIGURE 7.1. Planning framework.

a critical, evaluative stance when it comes to considering sources and source material found online. An essential aspect of developing such a stance lies in providing students with disciplinary expertise, so they can evaluate and interpret what they are gathering, using the same specific considerations that an expert within that discipline might use.

Teaching critical evaluation as both a discipline-specific and digital practice will not only help students better understand the disciplinary content they encounter but also aid them in becoming critical consumers of all content they find online. Students' ability to evaluate online information is strengthened when they are presented with the criteria used in a discipline and are encouraged to use these criteria (Duncan, Tate, & Chinn, 2014; Schwarz & White, 2005). The evaluation of online information must converge with digital practices for accessing quality content. Leveraging both areas in an integrated way invites learners to become informed, yet critical, consumers of disciplinary knowledge—an indispensable and fundamental condition for participation in an information-rich digital world.

Using and Representing Online Information

Today's classrooms require learners to be adept and flexible when in working across different modalities and between online and offline learning spaces, all the while synthesizing and making sense of information that comes from a wide variety of sources and perspectives. Experts within different disciplines explore topics in depth, using a range of resources. These experts collect data, debate ideas, and explore multiple perspectives. The information sources they use include digital simulations, animated 3-D models, or embedded images, audio, and video segments that are linked within and between different texts. These resources are generally read in a less linear manner than text-only information and require instructional scaffolding and extended practice if students are to engage in quality synthesis.

Gathering ideas from the multiple types of representations identified earlier involves layers of interpretation. In a digital world, meaning making is also a collaborative, networked activity that involves many individuals with different kinds of expertise. Discussion is often part of this process and includes both face-to-face and virtual discussion, the latter often being mediated through a shared, networked collaborative space such as Hypothes.is (<https://web.hypothes.is>). This space provides

an online forum to hold discussions, read socially, organize a collection of reading materials and research archives, and take personal notes. Hypothes.is and other similar digital tools provide a collaborative context for synthesizing ideas drawn from multiple resources and offers a means for discussing them with other learners. Such digital activities mirror the forums disciplinary experts use to exchange ideas, track the evolution of their thinking, and post ideas for critique and discussion with other disciplinarians. Incorporating this type of flexible digital form into classroom instruction invites multiple perspectives and encourages the examination of ideas from different points of view. These practices are commonplace in the disciplines and can readily be included as part of disciplinary learning in classrooms.

Producing and Exchanging Online Information

When individuals engage digitally and collaborate dynamically, multiple opportunities exist to create and build knowledge. In the discipline of science, drawing conclusions that come from first- and secondhand investigations is a critical component of the inquiry process. These conclusions can then be discussed, debated, and circulated within the disciplinary community. However, disciplinary learning should also lead to knowledge production and critique of the models and representations generated. Students need to possess both digital and disciplinary literacies to produce such representations of their own learning. The digital tools that they employ, the representations that they create, and the media that they use to communicate their ideas offer valuable practice in constructing knowledge.

Disciplinary learning requires discussion, data gathering, synthesis, argumentation, and data interpretation. Digital networks can support these processes in authentic and meaningful ways. For example, digital tools afford opportunities for students to engage in both synchronous, or concurrent, and asynchronous discussions that promote idea sharing and authentic argumentation. Additionally, digital networking can be used to connect learners with disciplinary experts via tools such as Zoom, Skype, Google Hangouts, and Twitter. Finally, digital tools afford opportunities for students to construct knowledge using multiple modes, such as video, audio, image, text, and combinations thereof. Digital and disciplinary literacies are not simply additive, they are generative, providing possibilities for creating, comprehending, communicating, and critiquing knowledge.

Implementing Digital Literacies for Disciplinary Learning

In this section, we introduce important implications for turning the three potentials discussed in this chapter into pedagogical realities across in- and out-of-school learning environments. The implications are aimed to spark changes in practice and possibilities for future research.

Implication 1: Contextualize Digital Literacies within and across Meaningful Learning: Make Connections across Content and Grade Levels

Teaching digital literacies for disciplinary learning requires a commitment to coherent and sustained instructional design and practice. As a result, the use of digital texts and tools needs to be orchestrated in ways that build both new strategies and new content knowledge. However, limited integration or one-off uses of digital texts and tools will not lead to the types of disciplinary knowledge building and sharing that is needed to solve the intellectual and social problems of the 21st century. Rather, instructional design and formative assessments of students' disciplinary learning should progress across grade levels and deepen over time. Only then can fluid, flexible use of digital literacies be applied independently in the context of the disciplines. Ideally, integrated digital and disciplinary approaches to learning would be introduced and continue across instructional sequences that extend across disciplines, so that they become tools for deepening disciplinary inquiry.

Implication 2: Overcome Limited Instructional Time: Increase Interdisciplinary Instruction, Materials, and Lesson Sharing

Given the limited instructional time most teachers face, they understand the tension between depth and breadth of instruction. However, we argue that instruction should be driven by learning outcomes rather than discrete digital or disciplinary activities; nor should the use of a particular digital tool to represent knowledge serve as the driver of the learning task (International Literacy Association, 2018). Rather, intentionally designed and sequenced learning outcomes, grounded in disciplinary content and practices, should be used to create spaces to develop digital literacies for disciplinary learning. Planning strategically

for interdisciplinary instruction and implementing collaborative curation of learning materials can provide these open spaces for learning.

The first tension that exists in classrooms is the finite amount of time available to move through the curriculum. We advocate for the design of learning environments that capitalize on 24/7 access of digital texts and tools that can extend access beyond the traditional hours of the school day. Additionally, interdisciplinary approaches to learning offer opportunities to deepen skills across disciplines, and can be used to develop disciplinary lenses toward problem solving. These lenses can be used to build connections between the disciplines with the end goal of solving intellectual and social problems using the most innovative instructional approaches and cutting-edge tools.

The second tension that exists centers around time pressures—the finite amount of time teachers have to keep pace with the seemingly infinite possibilities of digital literacies for disciplinary learning. We advocate for collaborative curation of digital resources that converge with disciplinary practices. Twitter chats, Google docs and sites, and TES Teach with Blendspace (www.tes.com/lessons) are great places for teachers to connect, curate, and share resources for digital literacies for disciplinary learning. The next level for this type of sharing in schools involves building professional learning communities and providing professional learning that extends capacity through an iterative design process aimed at testing and retesting teaching innovations (see Hobbs & Coiro, 2016, 2018).

Implication 3: Build a Community Aimed at Testing Out Teaching Innovations: Collaborative Professional Learning

Research on professional learning demonstrates that sustained and collaborative learning communities make a difference in student learning (Desimone, 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). We advocate for professional learning that makes space for teachers, along with their colleagues, to design, iterate, and test learning tasks within and across disciplines. If teachers are to build students' disciplinary knowledge, then they themselves must develop their own means of digital and disciplinary engagement. Teachers rarely get opportunities to build, tinker, and create their own disciplinary inquiry. Making time for such activities supports their development, instructional planning, and implementation as they guide their students through similar processes.

As we discussed in the section on bidirectional expertise, we support collaborative professional learning, because it creates spaces for teachers to engage in their own learning while sharing the texts and tools used by students, and to develop digital and disciplinary skills and knowledge while being apprenticed by, and along with, their students.

Conclusion

Digital and disciplinary literacies are inextricably linked concepts that when coupled together, offer powerful opportunities to harness the learning potential of the Internet. This chapter argues that educators at all levels must make space for instructional practices that build on the synergies between digital and disciplinary learning. We describe synergistic practices centered around (1) bidirectional expertise, (2) democratizing knowledge production, and (3) expanded inquiry approaches, and suggest ways to use our planning framework (Castek & Manderino, 2017) to organize and embed digital literacies for disciplinary learning into classroom instruction. Taken together, the three synergies and framework of organizing principles provide guidance for teachers who seek to transform instruction and create powerful learning.

● IMPLICATIONS FOR PROFESSIONAL LEARNING ●

- Digital literacies feed students' motivation by tapping into their interest in accessing and sharing digital texts and tools widely. This engagement can be used to deepen and broaden disciplinary inquiry.
- The fluid nature of online and offline practices can be considered in the creation of an environment for students to engage in authentic disciplinary practices.
- The sharing of student work digitally, so that peers and teachers benefit, can serve to empower students.
- The power of digital texts and tools should be harnessed to make disciplinary knowledge and practice accessible to all learners.

QUESTIONS FOR DISCUSSION

1. How are digital literacies and disciplinary literacies connected and mutually interdependent?
2. What types of learning potentials exist when digital literacies for disciplinary learning become intentionally interwoven?
3. How do the elements in the planning framework work together to facilitate instruction around teaching digital literacies for disciplinary learning?
4. What lessons and learning principles can be drawn from research around in- and out-of-school contexts and after school learning environments?
5. What types of disciplinary practices can be taught through digital literacies?

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