Supporting Digital Literacy in Educational Contexts: Emerging Pedagogies and Technologies

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Supporting Digital Literacy in Educational Contexts: Emerging Pedagogies and Technologies

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EXECUTIVE SUMMARY

A research team at University of California, Irvine conducted a synthesis of literature on digital literacy. The purpose of this synthesis was to 1) define digital literacy as it applies to K12 settings; 2) identify the best pedagogical practices for promoting digital literacies in K12 classrooms; 3) pinpoint teacher education and professional development practices for teaching digital literacies; and 4) review technology integration frameworks and distinguish which components best support digital literacy education.

This report includes a research synthesis of experimental research, case studies, qualitative analyses, and theoretical and pedagogical frameworks. The report addresses the technological, pedagogical, and social practices that contribute to digital literacy development across multiple countries and for students from linguistically, socioeconomically, and culturally diverse backgrounds.

Given the central role of information and communication technologies in all aspects of 21st Century life, digital literacy is a critical element of successful participation in academic life, the workforce, and society. Formally, digital literacy refers to the multiple ways that people use digital media to make meaning from and with texts and other symbolic systems relevant to particular societies and contexts. In an elementary and secondary school environment, digital literacy initiatives should enhance learners’ ability to participate in society operationally (the ability to read/write), culturally (the ability to understand texts within cultural contexts), critically (recognition of social construction of knowledge and digital media practices), creatively
(the means and skill for content creation), and collaboratively (the ability to work with others via digital means).

Although access to digital media is a necessary element of developing digital literacy, it is far from sufficient, and indeed, digital literacy initiatives that rely merely on passing out computers tend to have poor results. A better perspective is to view digital literacy as a form of social participation, which thus require a broad range of physical, digital, human, and social resources to develop. In school contexts, educators should consider how digital media could be deployed to facilitate inquiry, action, and reflection, and thus the types of curriculum and instructional practices that would be supportive. Throughout this report, we provide examples of thoughtful deployments.

Digital literacy certainly overlaps with the traditional literacies of reading and writing traditional print sources, but it cannot be reduced to them. For primary and secondary teachers, a key focus should be how digital literacies intersect with and enhance academic literacies. This can involve leveraging and repurposing many of the digital media practices students might be involved in at home, such as social networking or multimedia production, for academic purposes.

Pedagogical practices to promote digital literacy can focus in four areas: content, composition, construction, and community. Content strategies exploit the power of digital media to help students access, comprehend, and make use of the wide array of materials available online. These strategies should focus on just-in-time learning, individualized learning, and enhanced information literacy and student research.
Composition strategies emphasize the importance of informational writing. Social media and cloud-based environments give students the opportunity to practice the kinds of collaborative writing that are increasingly of value in academia and the workforce, and thus develop both their traditional and new literacies. Automated writing evaluation software can enhance students’ abilities to monitor their own progress and revise their work.

Construction strategies emphasize the importance of student meaning making with multimedia. Students should be encouraged to “resemiotize” by interpreting across semiotic boundaries, to critique and create persuasive multimedia documents, to master new multimedia genres, and to use multimedia to document and reflect on their own work. From a practical standpoint, this might involve interpreting a poem visually or musically, using a different modality to explore meaning.

Community strategies exploit the power of online networks to bring learners together. Computer-mediated conversation within a classroom can enhance students’ academic language and critical reasoning and argumentations skills. Partnerships with students elsewhere can encourage students to critically reflect on and explain to others their own context. Outside mentors can serve to encourage students’ project work and lend it expertise. All of this can be combined in collaborative project work that involves solving real-world problems and creating authentic written and multimedia projects.

Finally, new forms of performance assessment of these authentic projects can help evaluate the extent to which digital literacy goals are met. Educators can use digital portfolios, peer evaluation, and more holistic assessment rubrics for evaluation.
Teachers need to experience the same kinds of digital literacy practices that they hope to engender in their students. Professional development experiences need to be ongoing, rather than one-shot, and focus largely on the pedagogical practices and goals, rather than mastery of tools. Teachers need to learn to become facilitators, but not passive “guides on the side.” Rather, they must learn to fill a variety of rules, including carrying out direct instruction when needed. They need to learn to be lecturers, mentors, orchestrators, and designers, in addition to guides.

To help develop these capacities, instruction related to use of technology should be integrated into all (or many) pre-service courses, rather than taught in a single special technology course. In addition, teachers need to learn how to make use of their own online networks for lifetime support and professional development.

The TPACK framework — based on the integration of knowledge about technology, pedagogy and content — is especially helpful for teacher development, as it steers teachers away from a narrow focus on hardware and software. Rather, teachers are challenged to integrate technology in a way that enhanced pedagogical practices for the specific content areas they are teaching.

Other frameworks typically encourage transformational practices with new technologies. These frameworks can assist teachers in critically reflecting on their practice, but must be used critically. For example, a single-minded focus on “transformation” can end up emphasizing the technology involved rather than the learning. What some consider lower-level integration of technology, involving substitution, for example, may be quite significant for digital literacy. There are many kinds of literacy and learning practices and goals that are cumulative, rather
than transformative in and of themselves, and are still worthy of integration into the curriculum.

CHAPTER 1: INTRODUCTION

Background

The International Baccalaureate Organization (IB) currently reaches over 1.2 million students in almost 4,000 schools in more than 140 countries (http://www.ibo.org/who/index.cfm, retrieved Dec. 4, 2014). The IB emphasizes the development of the intellectual, personal, emotional, and social skills to live in an interconnected, global world. The program includes a Primary Years Programme for students from 3-12 years old, a Secondary Years Programme for students 11-16, a Diploma Programme for students 16-19 and a Career-related Certificate Programme for students 16-19. This paper focuses on the first three of these programs. The IB emphasizes a high-quality curriculum and pedagogical leadership.

Given the central role of information and communication technologies in all aspects of 21st Century life, digital literacy is a critical element of successful participation in academic life, the workforce, and society. Formally, digital literacy refers to the multiple ways that people use digital media to make meaning from and with texts and other symbolic systems relevant to particular societies and contexts. In an elementary and secondary school environment, digital literacy initiatives should enhance learners’ ability to participate in society operationally (the ability to read/write), culturally (the ability to understand texts within cultural contexts), critically (recognition of social construction of knowledge and digital media practices), creatively
(the means and skill for content creation), and *collaboratively* (the ability to work with others via digital means).

**Purpose of Study**

In order to identify best practices for integrating technology as part of an IB education, researchers conducted a synthesis of literature on digital literacy. The purpose of this synthesis was to 1) define digital literacy as it applies to K12 settings; 2) identify the best pedagogical practices for promoting digital literacies in K12 classrooms; 3) pinpoint teacher education and professional development practices for teaching digital literacies; and 4) review technology integration frameworks and distinguish which components best support digital literacy education.

This report includes a research synthesis of experimental research, case studies, qualitative analyses, and theoretical and pedagogical frameworks. The report addresses the technological, pedagogical, and social practices that contribute to digital literacy development across multiple countries and for students from linguistically, socioeconomically, and culturally diverse backgrounds.

In order to address the broad scope of practices that constitutes *digital literacies*, this report reviewed literature and synthesized research from across educational theory, practice, policy, new literacies studies, information and computer sciences, and across multiple countries including South Korea, Australia, and the United States. The following research questions guided this investigation:

1) *What does it mean to be digitally literate?*
2) What pedagogical practices and strategies can foster the development of digital literacies?

3) How can teacher training and other professional development efforts help promote digital literacies?

4) What is the role of technology integration frameworks in promoting digital literacies?

CHAPTER 2: METHODOLOGY

In order to compare literature across these fields and countries, this review conducted a between-study analysis design (Onwuegbuzie, Leech, & Collins, 2012). The overall approach for this review triangulates across the diverse literature on digital literacy and to settle upon key themes and definitions of digital literacy, practices and evaluation methods and their outcomes, and professional development strategies for educators.

Inclusion and exclusion criteria

In order to obtain a representative breadth of literature, the research team developed inclusion and exclusion criteria based on key domains. These domains include theoretical explorations of digital literacies and digital inclusion; digital literacy and practice; and technology integration frameworks. Because the research questions address conceptual as well as practical issues, the report examines a spectrum of papers including empirical research, policy guidelines, pedagogical approaches, and theoretical frameworks.

Search process

The initial literature search used keywords to find literature and other keywords. When an initial body of literature was been found, backward and forward searching strategies were
used (Webster & Watson, 2002). These strategies included 1) *backward references searching*, e.g., searching through the references articles, 2) *forward and backward authors searching*, e.g., using the initial body of literature to identify authors and then search their other publications for related literature, 3) *previously used keywords searching*, or examining keywords used by the articles yielded in the initial search, 4) searching through *forward references* or articles that cite the initial articles found (Levy & Ellis, 2006). This search was iterated until, as Webster and Watson (2002) suggest, “You can gauge that your review is nearing completion when you are not finding new concepts in your article set” (p. 16).

**Screening and coding**

The research team collaborated to screen the yielded articles based on inclusion and exclusion criteria. Because articles could address multiple research questions, open coding was used to identify articles that fit each research question. Articles were also grouped by country/region. Researchers used these open codes to identify initial themes in the text.

**Narrative synthesis and recommendations**

Researchers constructed a narrative synthesis around each theme (Popay, et al., 2006). Based on this synthesis, key recommendations for IB educators were developed; exemplary cases from the literature were selected used to clarify these recommendations.

**CHAPTER 3: SYNTHESIS OF RESEARCH**

**What Does it Mean to Be Digitally Literate?**

**Conceptual development of digital literacy.**

Although a relative newcomer to education and schools, digital literacy education has become an imperative. This literacy, many claim, will become (and in many instances, already
is) vital to participation in higher education, modern economies, politics, and basic day-to-day activities. Even in its very short existence as a concept, what digital literacy means has changed rapidly and meant different things to different people.

Initial conceptualizations of digital literacy first emerged with the development of personal computers and the Internet. Because computers and networked communication were viewed simply as extensions of traditional print communication, so too digital literacy came to mean the specific skills necessary for using these technologies. Even then, digital literacy encompassed many different skills, including the physical ability to type and move a mouse as well as the knowledge of how to use particular software (see Belshaw, 2012 for a history of digital literacy). This definition of digital literacy tends to be the popular view; however, researchers have long argued that this techno-centric approach ignores the social context of technology use (Lankshear & Knobel, 2007). As Warschauer (2002, 2003) points out, development of digital literacy requires access to four different types of resources: 1) physical resources such as computers and Internet connectivity; 2) digital resources including online texts; 3) human resources including education; and 4) social resources, the “community, institutional, and societal structures that support access to ICT” (Warschauer, 2002, np). Because students and schools are highly diverse, programs that address digital literacy must be flexible enough to accommodate curricular changes that take into account community- and student-level differences. Some effort might be established at the beginning of a program to evaluate what resources students have access to, which resources might need bolstering, and what resources students might especially be able to leverage.
What skills then are necessary to be considered digitally literate? Many scholars have shifted to consider digital literacy from within a multiliteracies framework. The concept of multiliteracies refers to the “increasing local diversity and global connectedness” that encompasses “multiple languages, multiple Englishes, and communication patterns that more frequently cross cultural, community, and natural boundaries” as well as “the ever broadening range of specialist registers and situational variations in language” (Cope & Kalantzis, 2000, p. 64). Rather than simply being “literate,” we may be fluent in many niche “languages”—from regional slang shared only with neighbors to the specialized knowledge and lingo exchanged between two high school teachers discussing pedagogy. Similarly, digital literacy might be considered as a diverse group of digital literacies, from the social and technical knowledge to maintain a social network on Facebook to the ability to design and develop a web page in HTML5.

Rather than simply the ability to read and write digital texts or use a computer, one approach is to view digital literacies as participation in various digital practices. According to Lankshear and Knobel (2007), “literacies always involve much more than simply producing and negotiating texts per se,” and digital texts and tools have different meanings depending on who interacts with them, and digital literacies might be considered in terms of participation rather than as a specific skillset (p. 6). Similarly, Belshaw (2012) proposes that digital literacies are comprised of many dimensions including cultural, communicative, and constructive practices. For example, a young person might participate in an online community dedicated to fan fiction writing and critique, where she seeks and provides feedback on peers’ digital texts (cf. Black, 2009). Others might create “machinima,” or “the process by which fans use video game
animation ‘engines’...to render new animated texts” and post their video creations to YouTube (Lankshear & Knobel, 2007, p. 8).

Yet another definition of digital literacy is the alternative perspective of digital participant. “To be a ‘digital participant’...means making informed use of digital technology and media in one’s own life,” in other words, to be able to “read” and “write” with new digital media and to be able to obtain and share knowledge via these platforms (Hague & Williamson, 2009, p. 3). Echoing the components of digital literacy suggested by Belshaw (2012), these authors suggest there are five dimensions of digital participation: operational (the ability to read/write), cultural (ability to understand texts within cultural contexts), critical (recognition of social construction of knowledge and digital media practices), creative (the means and skill for content creation), and collaborative (the ability to work with others via digital means).

The ultimate goal of digital learning in Singapore is to have students ready for a collaborative and technologically savvy society. This is evident in the focus of policies, which have shifted from teachers’ e-learning integration into learning tasks to students’ capacity building (Kong et al., 2014). A student-centered learning process is supported by recently developed mobile technology. This learning process is targeted at the development of 21st Century skills and students are expected to be competent in research, analysis, and publication of information using various media tools.

The meaning of digital literacy continues to change as new technologies emerge and change the ways people interact with digital information. Moving forward, a comprehensive definition of digital literacies might encompass multiple definitions; digital literacy can be thought of as resources, participation, and specific technological, social, and thinking skills. However, current research suggests that an integrated, digital-literacy-as-practice approach may be more effective in educational contexts than a techno-centric, skills-based approach.
This approach might explicitly acknowledge the diverse digital practices that students bring with them into the classroom and the need for instructors to ground curricula in projects that are relevant to the lives of students—such as through interest-driven inquiry on topics that bridge content knowledge with students’ communities. In the next section, we discuss ongoing research on how to measure digital literacies, the success of programs aimed at digital literacy education, and how to approach inequality with regards to digital literacies.

**Research on digital literacies.**

**Ties with traditional literacies.** Much research on digital literacies examines the affordances of digital technology’s use for learning, particularly related to reading and writing. In their study on high achieving sixth-grade students’ strategies for navigating Internet texts, Coiro and Dobler (2007) found that this process required prior knowledge about the topics presented in the texts, making connections and inferences across texts, and self-regulation of reading, e.g., awareness and control of one’s reading process. These findings suggest that digital texts introduce new dimensions to reading—including the necessity to develop certain skills, knowledge, and even “cognitive flexibility” to balance prior knowledge, reading comprehension strategies, and self-regulation.

The format of digital texts may also allow new readers, English language learners, and students with disabilities to customize texts so that they are more readable. For example, the software LiveInk uses an algorithm to transform the format of digital texts into a cascading, poem-like format that breaks sentences into chunks that are intended to be easier to process (Walker & Vogel, 2005). Digital texts can also be more easily made available in multiple
languages, roughly translated on the fly, and packaged with glosses, visual supports, and audio pronunciation assistance.

**Digital divides.** Results of these measures and assessments have, however, revealed concerns of equity with regards to digital literacies. In the US, school resources generally reflect the wealth of the surrounding area; schools in low-income neighborhoods tend to have less access to computers and the Internet at school (Lenhart, Arafteh, Smith, & Macgill, 2008). Although youth are often referred to as “digital natives,” surveys of these populations suggest that there are disparities in their digital skills and activities (Hargittai, 2010).

These differences persist despite similar access to technology, suggesting that this is not only an access issue but also a problem of inclusion in digital practices. Beyond mere access to technologies such as computers or the Internet, unequal access to social and academic support for learning how to use these technologies (and how to use these technologies to create, collaborate, and explore) might be creating a *digital divide* among students from low-socioeconomic status (SES) or underrepresented minority backgrounds. There are differences in how students use computers at school. For example, one study found that use of technology tended to decrease academic outcomes among students in low-SES schools, likely due to drill and practice activities favored by teachers in those schools (Wenglinsky, 2005). In one example, a high-SES middle

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In Australia, the Tech Packs Project, a part of the Computer for Every Child Project, provided computers to a group of families that could not afford computers. Yelland, Neal, and Bakich (2010) surveyed those family members (N =272) to determine the extent of technology use before and after receiving the computer and interviewed them to explore how owning a computer affected the proficiency of their digital literacy. They found whole families more frequently accessed new technology, transferred knowledge across generations within a family, and more actively participated in communities. In particular, school-age children, who reported that 83 percent of computer use was for school research or study purposes, were able to complete school assignments more easily, could pursue further study, and improved in school achievement.
school used computers and Internet access to conduct research using primary sources, whereas a low-SES middle school with the same access to reference databases spent their computer time creating simple Power Points using dubious sources and copy-pasting text and images from websites (Warschauer, 2007). In another example, Neuman and Celano (2006) compared the introduction of computers to libraries in two low- and middle-income neighborhoods. They found that the practices of the librarians and the community were quite different. Whereas librarians and parents supervised and guided children’s use of technology in the middle-income neighborhoods, children in the low-income community were left largely to their own devices and did not have the benefit of such guidance. Rather than shrinking the digital divide, the introduction of computers widened the “gap” in technology and literacy practices between these libraries.

For low-SES students, who are less likely to have access to technology at home, scaffolded access via spaces such as libraries and schools may be especially important (Warschauer & Matuchniak, 2010). These spaces should integrate both basic and advanced technology skills and to leverage technology to enhance textual content. Visuals such as images and video can scaffold texts, and hyperlinks within digital texts can enable students to access definitions or additional content. Backchannel communication—such as a chat room running concurrently with an in-person discussion—can provide a way for teachers and students to hyperlink to relevant content and for students to practice writing and reading.

The digital divide is not restricted to U.S. sites. South Korea has launched the Cyber Home Learning System to bridge the education divide between regions and socioeconomic classes in an effort to decrease the evidently disproportionate quality in students’ education.
(Chang, 2008). Due to the cost of private education, specifically English education, there is a great inequality in access to supplementary education. Since 2004, the country has provided students with supplementary learning content to study voluntarily at home through the Internet to reduce the cost of private tutoring. This content is designed to eliminate the educational divide in elementary and middle schools. The program proved to be popular and is used by more than 3 million students, half of who come from rural areas or lower-income backgrounds.

As educators have grown to recognize the need for digital literacy education, programs and initiatives have been developed to address this need. In general, evaluations of such programs suggest that initiatives that simply provide technologies to schools and students without appropriate pedagogical, technical, and community support tend not to boost students’ academic achievement. For example, one-to-one computer programs have been proposed as one way to increase opportunities for students to gain experience with new technologies. In the U.S., one program targeted primarily at low-SES and language minority students boosted proficiency in math and reading in addition to enabling students to use the Internet and computers for collaborative learning. A study of this program found that a professional development program that included strategies for integrating technology in teaching and assessment boosted student achievement (Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011). This study also found that prompting students to not only format but also draft and revise writing on laptops improved writing outcomes. In a similar one-to-one program, individual differences across teachers was found to vary significantly when a computers were distributed, with some teachers integrating technologies and others using computers only to
augment their prior curriculum (Bebell & Kay, 2010). The authors suggest “it is impossible to overstate the power of individual teachers in the success or failure of 1:1 computing” (Bebell & Kay, 2010, p. 48). Differences in technology infrastructure and teacher professional development could also lead to unequal academic outcomes, as Shapley and colleagues (2011) found in their study of laptop programs in middle schools. This line of research has illuminated specific approaches to successfully incorporating digital literacy into educational contexts. We review these approaches in in- and out-of-school contexts.

**Digital literacies in educational contexts.**

**Out-of-school educational contexts.** In terms of the affordances and challenges of using digital literacy for learning, case studies tend to examine either digital literacy practices and learning in out-of-school contexts (e.g., Black, 2009; Gee, 2004; Jenkins, 2009; Lam, 2000) or in-school contexts and how to bring out-of-school digital literacies into the classroom (e.g., Gee, 2010; Hull & Schultz, 2002; Salen, 2011).

Youth are often referred to as *digital natives*, with an almost innate knack for technology, so it is no surprise that much research has explored how young people develop digital literacies through their own interest-driven, out-of-school practices. Ito and colleagues (2008) captured a range of these practices in their ethnographic work on young people using digital media. They found that youth often participate in “always on” communication via Internet-capable devices including computers and phones. They also described three patterns of participation: 1) *hanging out* or casual participation in digital practices such as using social media to chat with friends; 2) *messing around*, or exploring and participating in interest-driven activities such as a student teaching herself how to build computers; and 3) *geeking out*, or
strong engagement with technology or media, the development of niche expertise, and the often collaborative construction of new media. The authors suggest that students who are highly engaged with technology may have more opportunities to engage in peer-based learning as they share and seek out information on their particular interests online.

There are many examples of young people engaging in these “participatory cultures,” e.g., collaborative and creative communities that provide mentorship and social connections (Jenkins, 2009). Connected learning has been proposed as one way to describe the learning that takes place outside of schools in digital and real life spaces—from makerspaces to video game forums. Many of these alternative-learning spaces function via peer-based learning. For example, an online community surrounding the strategy game Starcraft produces videos on gameplay strategies offers participants “coaching,” and engages in discussion and analysis of gameplay technique (Kow & Young, 2013). An emerging area of research is the development and popularization of hackerspaces and makerspaces (Moilanen, 2012). These spaces enable individuals to share knowledge, tools, and materials to hone their skills—from web design and crocheting to welding and software hacking, depending on the focus of the space and the expertise of the “hackers” and “makers.” Although these spaces generally exist outside of school, some have proposed that offering students a space where they can similarly explore their interests as they
build and create, such as the Tinkering School in California where students are encouraged to “tinker” with technologies, or the Los Angeles Makerspace, a “kid-friendly” space “where youth can make and learn alongside adults and where members can work on their own projects while learning new, unique maker skills” (Colegrove, 2013; www.tinkeringschool.com; LA Makerspace, 2014). Many of the skills used in these spaces require digital literacy of some type.

Understanding the motivation for students to adopt new technologies and develop digital literacies is key to integrating these practices into curricula. Identity development may be an especially important motivator for developing digital skills. In their study of how Indian immigrants and their US-born children use the Internet, Skop and Adams (2009) found that digital spaces were important “for overcoming separation at intra- and international scales, for creating a variety of connections across space and for constructing a sense of identity” through consuming and producing online media and chatting with distal friends and family (p. 128). In her seminal paper, Lam (2000) conducted a case study of an immigrant teenager who developed both digital and traditional literacy skills as he worked to construct his online identity through a personal website. In order to create this website and communicate with an online community of peers, he acquired web development and second language writing skills. Much like the students in Black’s (2009) study in the sidebar, he leveraged his personal knowledge of fandom and language to cultivate his online presence. In developing curricula, educators must recognize the importance of shaping and broadcasting identities among young people—and of appreciating the specialized knowledge and interests that students bring with them into the classroom.
In-school contexts. In addition to research examining out-of-school digital literacy practices, many educators have explored in-school contexts as sites for digital literacy education. The following summarizes two general approaches: one focuses on boosting classroom access to technology, the other focuses on the types of technology and pedagogical practices used. In order to explore the spectrum of what digital literacies encompass and how educators have approached this topic in classrooms, we review contexts and cases of digital literacy education from several countries throughout this paper. For each case, we identify their outcomes and the strengths and weaknesses in their approaches.

One-to-one computer, laptop, or tablet initiatives have become more and more widespread worldwide. Through these initiatives, each child receives access to a device (usually a laptop or tablet) that is available throughout the school day and, sometimes, can be taken home. Most of these programs also fund and emphasize professional development relating to the technology implementation, curriculum development, and Internet infrastructure. A meta-analysis of 57 studies of these programs found that these programs had an overall moderate positive effect (.24 standard deviations) on math, science, reading, writing, and language arts test scores (Zheng & Warschauer, 2013). Students in laptop programs tended to engage in more project-based learning (Cavanaugh, Dawson, & Ritzhaupt, 2011; Corn, Tagsold, & Patel, 2011), write and revise more and in a wider variety of genres (Grimes & Warschauer, 2008), and benefit from more individualized instruction (Corn et al., 2011; Russell et al., 2004). Relationships between teachers and students and between homes and schools were also improved (Lei & Zhao, 2008).
Not all one-to-one programs are successful, and one case study of a U.S. laptop program in Alabama provides a cautionary tale. This initiative was part of the One Laptop per Child (OLPC) program, whose goal is to transform education by providing students with personal laptops (One Laptop per Child, n.d.). A mayor in Alabama contracted with OLPC as part of an effort to increase technology skills and overall academic performance among students in the predominantly low-SES school district. However, a top-down implementation, lack of teacher training, poor wireless Internet infrastructure, and failure to secure parent and community engagement meant that the introduction of laptops generally did not result in more digital literacy practices in these schools (Cotten, 2010). However, a comparative case study of this program with two other US one-to-one laptop programs in California and Colorado did find some use of OLPC laptops in teacher-led afterschool computer programming clubs, underscoring the need for guidance and teacher investment in programs aimed at improving digital literacies (Warschauer, et al., 2014).

Consistent with the Alabama experience, Fairlie and Robinson (2013) conducted a randomized control study to determine the impact of laptops alone on academic outcomes.

As a result of the adoption of the CCSS in most U.S. states, educators have developed many different programs to prepare students for the standards and to assess their progress. Drew (2012) highlights several existing digital literacy education recommendations in her summary of the CCSS and digital literacy, including objectives for teaching online researching skills (Henry, 2006), information evaluation (Castek, 2012; Coiro, 2009), and connecting with peer learners and mentors via the online community ePals (ePals.com). Another example is the use of digital media skills via blogging. Zawilinski (2009) proposes using blogs beginning with students in elementary grades for tasks such as publishing classroom news and announcements, mirror blogs in which teachers and students post reflections on classroom content and readings, showcase blogs for students and teachers to post their work or interesting links and media, and literature response blogs where students can collaboratively write responses to prompts about classroom readings, enabling students to apprentice into online writing by linking a typically “real life” activity with a digital one.
Looking at 1,123 students in grades 6-10 in California, half of the students were given laptop computers. No other supports or interventions were used. Data collected from the school system on achievement outcomes showed no evidence of an effect on grades, standardized test scores, course completion, attendance, or discipline (Fairlie & Robinson, 2013). These findings suggest that simple access to technology alone is not sufficient to improve learning. Across our examples, common elements suggest that necessary technological access and infrastructure includes reliable broadband wireless network coverage and consistent technical support for repairing laptops and networks. Most in-school technology implementations involve a significant amount of curriculum development, professional development, community engagement, technology support and other factors that enhance the use of technology for learning.

Social networking and online web production tools have also been used as a way to promote digital literacies and collaborative, interest-driven learning in the classroom. For example, one teacher used blogging as a way to promote discussion and academic writing (Bloch, 2008). He suggested that the format and blog writing style, which might be more familiar to students, encouraged students to apprentice into other types of writing—such as formal essays—and into critical thinking and thoughtful discourse. In his class, students were instructed not only to blog, but to post comments and critiques on other students’ posts. Bloch proposed that the frequent critiques and back-and-forth discussions he saw in the students’ blog comments were due to “the distance between reader and writer” that occurs in digital spaces (2008, p. 162). Students also developed practical web skills in order to bolster their arguments and discussion points, such as linking to other online media. Using social media or
other online media creation tools, which include a variety of free web software that allows individuals to compose text, edit photos and videos, and to self-publish these online, may be a way to encourage participation and discussion while motivating students to develop their digital literacy skills.

Digital literacy, sometimes described as part of necessary “21st Century skills,” is an increasingly urgent topic among educators in the United States. Enmeshed with these skills are notions of academic excellence, economic competitiveness, and civic participation (Castells, 2010). As a consequence, U.S. policy has sought to improve digital literacy education. The Common Core State Standards (CCSS), a set of benchmarks and educational objectives for primary and secondary education, include digital literacy as part of their standards (Nat’l Gov. Assn. & CCSSO, 2014). These standards require that students develop specific research and information literacy skills, e.g., *Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words*, and technology skills, e.g., *Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others* (Nat’l Gov. Assn. & CCSSO, 2014, pp. 10, 18). These standards were intended to be flexible enough to encompass diverse technology practices while emphasizing the foundational skills—such as critical inquiry, evaluating sources, and collaboration—necessary for digital participation.

**Affordances and challenges of digital literacies.**

Although Ito and coauthors (2008) explore different genres of participation in technology use, they acknowledge that there are economic, social, institutional, and cultural barriers to participation in these activities. Studies suggest that unequal access to technology
and community-relevant academic and social support is of particular concern, as focusing on
digital literacy skills tends to exacerbate socioeconomic inequalities (e.g., Warschauer &
Matuchniak, 2010) as discussed above under “Digital divides.” Additionally, much research
suggests that rather than implementing a techno-centric approach, digital literacy should be
used as a means for students to engage in project-based collaborative inquiry, conducting
authentic research, and developing critical thinking skills. In terms of affordances, digital
literacy practices tend to best function when they are used in conjunction with collaborative,
project-based curriculum.

One challenge regarding digital literacies in school is the reliance on a techno-centric
approach. Too often, the tendency is to view technology education as modern and
automatically better—and to rely on technology alone to educate students rather than to
thoughtfully design an integrated curriculum, such as with One Laptop Per Child (OLPC) in
Alabama discussed above (Cotten, 2010). In another example, individual OLPC laptops were
deployed among rural schools in Peru in order to promote technology skills development.
Subsequent studies and evaluations of this effort found that this effort was largely unsuccessful
due to lack of educational and technological resources (Cristia et al., 2012). Moreover, the
program’s top-down approach ignored the needs of its diverse indigenous populations in favor
of a “modern” education and restricted view of what makes an “educated person” (Breitkopf,
In East Asia, most countries indicate their efforts to embark on an educational reform by constructing a stand-alone, sector-wide ICT (Information and Communications Technology, see Figure 1, Wallet, 2014). Moreover, these countries offer ubiquitous computing facilities for pedagogical applications by also having a high penetration of student cell phones with built-in features that include bilingual dictionaries, social networking sites, SMS, Email, Internet access, and video cameras (Meurant, 2008). Table 3.1 illustrates the relatively low learner-to-computer ratio (LCR) of the three East Asian countries (Hong Kong, Japan, Korea) and neighboring Asian countries. LCR is a proxy measure for the quality of computer-assisted instruction and it is used to compare the relationship difference between LCR and individual learner time using computers (Wallet, 2014). Hong Kong, Japan, and Korea have both high proportion of schools with CAI (100% and access to computer 9:1, 7:1, 5:1, respectively).
Table 3.1.

*LCR in primary and secondary schools, 2012*

<table>
<thead>
<tr>
<th>Country</th>
<th>Primary Proportion of schools with computer-assisted instruction (CAI) (%)</th>
<th>Primary Learner-to-computer ratio (LCR)</th>
<th>Secondary Proportion of schools with computer-assisted instruction (CAI) (%)</th>
<th>Secondary Learner-to-computer ratio (LCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippines</td>
<td>41</td>
<td>151</td>
<td>87</td>
<td>49</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>60</td>
<td>98</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Iran, Islamic Rep.</td>
<td>46</td>
<td>83</td>
<td>76</td>
<td>21</td>
</tr>
<tr>
<td>Thailand</td>
<td>99</td>
<td>15</td>
<td>99</td>
<td>14</td>
</tr>
<tr>
<td>Malaysia</td>
<td>100</td>
<td>17</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>China, Hong Kong</td>
<td>100</td>
<td>9</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>Japan</td>
<td>100</td>
<td>7</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Korea, Rep.</td>
<td>100</td>
<td>5</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Singapore</td>
<td>100</td>
<td>4</td>
<td>100</td>
<td>x</td>
</tr>
</tbody>
</table>


Over the past forty years, the Korean incorporation of ICTs in education has evolved continuously. In 1970, a governmental decree mandated that educational computing be incorporated into higher education and high schools. Since then, a number of policies have been implemented to create the appropriate technological infrastructure for educational technology. In present day, the 2006 educational technology policy focuses on incorporating multiple platforms (e.g., mobile phones, learning management system) into education for ubiquitous learning (Severin & Capota, 2011). Most recently, South Korea became the first country worldwide to replace traditional textbooks with digital textbooks in primary and secondary school settings. Not only did the interactive digital textbooks include the content of existing textbooks, reference books, workbooks, glossaries, etc., the content was improved by integrating digital media such as video clips and animation. In addition, content can be customized for each student’s characteristics and academic level (MEST, 2008). A recent study which focused on the effectiveness of student learning through the use of digital textbooks was perceived to generate several benefits (i.e., an increase in students’ problem solving skills, self-
directed learning skills), as well as an improvement in achievement results in various subjects, such as English, math, and science (Jeong & Kye, 2014). According to the interviews and surveys, these favorable outcomes did not flow from the devices themselves but were due to the contextual factors that accommodated the devices to instruction and student needs. These methods included solid curricular integration of digital textbooks, the use of digital textbooks in both in-class and after-school programs, tool training sessions for students/teachers/parents, and the use of digital textbooks for self-paced learning in order to meet the specifications of individual students (Jeong & Kye, 2014).

Similar to South Korea, Hong Kong has attempted to improve students’ learning outcomes by incorporating IT from the educational development plan in over 80% of the schools into their school development plan (Educational Bureau, 2012). The IT program resulted in more than 90% of the students in primary and secondary school sector having computer and Internet access at home (Educational Bureau, 2012). Additionally, approximately 13% of the school budget is spent on implementation of IT in education (Chen, 2011).

A recent national survey on Hong Kong teachers’ use of instructional technology reported an increased percentage in applying emerging technologies, such as Web 2.0 (e.g., blog, wiki, podcast), in primary and secondary school sectors (Educational Bureau, 2012). In the primary school sector, this percentage increased from 27% in 2010 to 41% in 2012; in the secondary school sector, the percentage increased from 40% to 53%. This trend is contrary to the observed trends in U.S. K-12 technology implementation, where primary students, rather than secondary students more frequently use technology. The reason for this reverse trend has not been clearly identified, but may be related to complications regarding IT facilities and
accessibility. In Hong Kong, the net student to computer ratio is slightly higher in secondary school (8.87:1) than in elementary school (8:71:1). It may be a result of the higher confidence level of secondary teachers in using IT in instruction (primary 90%: secondary, 96%). Students also reported high competence in their IT skills, especially skills in searching for information and computer operation. Boosts were also reported with regards to skills such as information selection, information analysis, reporting, and presentation, and proper use of IT.

In addition to the improvements in digital literacy outcomes, the Hong Kong national survey revealed that teachers were less dependent on pre-designed teaching materials and were more independent in customizing teaching resources to address learner diversity, which may be associated with their generally high level of confidence in using IT as discussed above. Furthermore, UNESCO’s global comparison on teacher preparedness of ICT use also lists Hong Kong as one of the exemplary countries with a higher rate of teacher preparedness in ICT use: teachers are universally trained to incorporate ICT into classroom instruction (UNESCO, 2014). In addition to enhanced learning and teaching through the development of e-learning resources or innovative devices by alternative organizations, the use of Web 2.0 technology further transformed pedagogy and a students’ role from a user of learning resources to a director of self-learning.

Singapore provides another example of where policies have established school environments in which digital literacy education can be well integrated. To date, two national master plans have been introduced and the third one is currently under implementation (Kong, Chan, Huang, & Cheah, 2014). The first master plan, which was named Getting the Fundamentals Right (1997-2002), requested primary and secondary schools to provide students
ICT-related subjects. In the second master plan, *Consolidating the Insights* (2003-2008), there was an emerging consideration of a paradigm shift to student-centered learning through e-learning delivery. The third one, *Pushing the Frontier* (2009-2014) reflected a growing concern with the approach of mobile learning using learning platforms and e-resources. It is also noteworthy that Singapore educational reform policies are characterized by both centralization and decentralization (Ng, 2010). First of all, the nation provided top-down resources, such as the same infrastructure, an ICT expert, baseline guideline training for teachers and students, guidelines for distributing online learning, and courses across all schools (Barbour et al., 2011).

However, Singapore also allows schools autonomy so that they can develop community-relevant curricula for promoting literacy, creativity, and 21st Century competencies. Although digital literacy education has many potential affordances, there are also many potential challenges of implementing such initiatives. One challenge of implementing digital literacies education in schools is the potential for these practices to worsen existing inequalities among students, as discussed above under the heading “Digital divides.” On the other hand, bringing digital literacies into the classroom has the potential not only to lessen gaps in achievement due to student backgrounds but also to foster global, collaborative inquiry among students. In order to do so, educators must acknowledge the cultural and digital literacies that

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Although there is widespread support for the use of computers and digital resources in general education, teaching and learning of L2 digital literacy is limited in the some countries. At the primary and secondary levels, a variety of tools including both interactive (e.g., bulletin boards, chat rooms) and non-interactive (e.g., audio, video materials) multimedia sources are utilized to support English classes. However, these practices do not appear to extend to incorporating L2 digital literacy skills. Incorporating digital literacy in L2 settings enables learners to access, navigate, comprehend, and contribute meaningfully to English language online resources and the discourse of the online community (Meurant, 2009; Lotherington & Jenson, 2011).
students bring with them into the classroom, establish sustainable technical and professional development supports for schools and teachers, and design curricula that leverages the transformative potential of technologies for communication, collaboration, and authentic research.

In many East Asian countries (i.e., South Korea, China, Japan, Hong Kong, and Taiwan), digital literacy actively utilizes English as a second language (ESL: English used as an official second language, e.g., Hong Kong, Taiwan) or as a foreign language (EFL: English learned as a foreign language in a non-English-speaking region, e.g., South Korea, China, Japan) in their learning contexts. For English language learners, digital literacy practices can generate new possibilities. As a result of diverse media approaches for second language (L2) teaching and learning, students who speak English as a second or foreign language will receive an abundance of communicative interactions and will have the opportunity to build their digital literacy skills. Throughout the development of digital literacy skills, students will gain the ability, confidence, and readiness of a strong English speaker; their use of English as a second or foreign language will aid them in accessing, navigating, comprehending and contributing meaningfully to English language online resources and to online community discourse (Meurant, 2009; Lotherington & Jenson, 2011).

As technology-based activities such as online communication and web surfing become common cultural activities for students, language learners encounter English not as a subject they are forced to learn, but rather as a language impelled by their personal need to be able to communicate to the best of their abilities in online spaces. In this context, digital literacy helps the use of English become a more interest-driven, purposeful, and natural activity for second
language learners. Furthermore, for tech-savvy students in East Asian countries such as Japan, Korea, or China, where access to broadband is widespread (Reardon, 2005), digital literacy practices in English can be both empowering and synergizing; students can build their English as a second language skill upon their already advanced technology skills.

In addition to a technology-supportive environment, Hong Kong students’ overall high English proficiency due to the daily exposure to English as an official language and medium of instruction may contribute to the development of digital literacy practices. For example, Hafner (2013) examined an undergraduate English for Academic Purposes (EAP) course (i.e., using English in a science class) at a university in Hong Kong, which incorporated elements of digital literacies. His analysis of learners’ multimodal scientific documentaries, YouTube digital videos, lab reports, as well as student interviews and blog posts revealed that students combined a range of multimedia modes to appeal to both their general and specialist audiences, developing appropriate discourse identities through the course. Students used different visual representations, registers, and identities in the discourse based on their assumptions about their relationship with the audience (general vs. specialist audience). They adopted a range of discourse identities from scientists, investigative journalists, and travelers with different purposes (to educate, to investigate, and to entertain) during the scientific experiment. Students expressed varying discourse modes through appropriate use of L2 and other multimodal sources such as image and sound. In an online science project, L2 students developed their discourse identity as well as academic language skills. This finding suggests the potential affordances of utilizing digital literacy in English learning contexts.
Another challenge with implementing digital literacy curricula is the danger of using a top-down, community-agnostic approach as discussed previously. One way to bring sociocultural contexts into the classroom and to encourage cross-cultural inquiry through digital literacies is to encourage the cultural knowledge that students bring with them into schools (Hull & Schultz, 2002). For example, in Project FRESA, a teacher began with a premise relevant to her third grade class of immigrant field workers’ children: strawberries (Cummins, Brown, & Sayers, 2007). Students used digital tools to conduct research and publish their work online. These digital tools enabled students to achieve academic goals, but the community-oriented nature of the project motivated the students. Their teacher described the project’s impact: “It made a world of difference having something the students could connect to and relate to” (as cited in Cummins et al., 2007). Similarly, Crandall (2009) developed a yearlong project-based curriculum for high school seniors wherein they produced multimedia presentations based on their research. These projects were community-based and involved authentic research. Crandall suggests that focusing on conducting online research and producing digital texts via project-based learning is key because “[d]igital literacy is a growing expectation of higher education, employers, parents, and students” (p. 108).

**Enabling student practices.**

Digital literacies enable students to develop technical skills and knowledge, while engaging them in learning and supporting identity development, participation in a global society, and collaboration with peers (Ito et al., 2008; Selwyn, 2009). Differences in student digital skills suggest the important role of teachers in scaffolding the development of these skills within the context of curricula that is relevant to the students’ interests (Cope & Kalantzis,
2000; Luke & Luke, 2001). If being “digitally literate” is viewed as digital participation, rather than as a minimum competency or threshold in specific technologies, as Lankshear and Knobel (2008) suggest, then the pedagogical approach must likewise support students in the practices that enable this participation.

**Figure 3.2**
*Middle school student tablet use.*
Student constructing animated PowerPoint on stock prices after school.

*Source.* T. Tate, 2014.

Digital literacy can contribute to promoting digital participation by providing students with the skills and awareness to engage with new technologies—and in turn, develop their academic, social, and civic engagement. Digital media literacy education is associated with increased political engagement, perhaps because these literacies enable young people to better access information and connect with ways to take civic action (Kahne, Lee, & Feezell, 2012). Similarly, research has shown that participation in social media has social benefits for young people, especially during times of transition or stress (Subrahmanyam, Reich, Waechter, & Espinoza, 2008). However, there is also evidence that productive use of social media is a learned skill that emerges over time (Wang, et al., forthcoming). Fluency in these media and familiarity with these specific skills and realms of digital participation, then, may be key to helping students access the benefits of digital participation.
Mere participation or use does not equate to technological competency, however. For example, youth who effectively use Instant Messaging (IM) must know how to convey and interpret tone via text and emoticons, understand surveillance and privacy, and assume identities online (Lewis & Fabos, 2011). Many studies suggest that computer mediated communication skills vary significantly among young people (e.g., Hargittai, 2002). Seeking emotional support on Facebook, for example, requires knowledge not only of how to post, but also of what to post and when to post so that friends and family see it (Newman, Lauterbach, Munson, Resnick, & Morris, 2011). Similarly, a recent study suggested that although faster, note taking via computers tended to encourage verbatim notes more than taking notes on paper (Mueller & Oppenheimer, 2014). While Mueller & Oppenheimer suggest that the technology is responsible for this difference, Jones (2014) suggests that this study “demonstrates the need for explicit instruction in how to most effectively take notes.... In other words, it points to the need for digital literacy instruction” (para. 24). Competency, then, must encompass not only familiarity or use of technology, but also the understanding of how to select appropriate technology for the situation and use it to the best advantage.

Some understanding or fluency in specific technologies appears to be beneficial; however, technologies are constantly changing—and a student without competency in one platform or technology may have competencies in others that afford her similar benefits. As an alternative, digital literacies education should move away from a strictly “competency” based model and towards technology integration and engagement with the practices that translate across specific technologies. Such practices could include those described in digital literacies theoretical frameworks, such as those proposed by Lankshear and Knobel (2008), who suggest
that digital literacy is “a quality of the person, not an externally-defined threshold to be attained. There is no ‘one size fits all’” measure of digital literacy (p. 168). Instead, they propose four components of digital literacies: underpinnings, or the traditional idea of digital literacies as technology skills and competencies; background knowledge, the understanding of how information and resources are created and distributed; central competencies, or the ability to read, understand, and create digital texts; and attitudes and perspectives, the ability to learn independently, responsibly, and with a mind towards inquiry.

These components echo those established in International Baccalaureate documents regarding the role of ICT in the program, which emphasize student-driven, authentic inquiry and cross-curriculum collaborative learning (International Baccalaureate Organization, 2011; International Baccalaureate Organization, 2013). In the development of curricula and learning objectives for digital literacies, an acknowledgement of these core components of digital literacies is key. Although IB literature on the topic of information and communication technology use emphasizes collaborative inquiry and co-construction of knowledge, emphasis of technology as a tool might be elaborated. While technology use can be a tool to augment these practices, as examples have shown above, digital literacy practices might also serve as a site for inquiry, action, and reflection, in addition to a means for it. Just as self-regulation and self-awareness are important for reading Internet texts, digital literacy education in general might benefit from students learning to evaluate and regulate their digital media creation and consumption (Coiro & Dobler, 2007).
What Pedagogical Practices and Strategies can Foster the Development of Digital Literacies?

Research in and out of school suggests that digital media can enhance four crucial elements of classroom instruction, which Warschauer (2011) has labeled content, composition, community, and construction. To understand how each of these four elements aids learning, it is helpful to take another look at out-of-school learning, and particularly the advanced learning experiences of those who are able to “geek out” with new technologies in home environments (see examples in Gee, 2003, and in Ito et al., 2009). First, highly successful out-of-school learners use computers and the Internet to access individualized, differentiated, rich, and interactive content on topics they want to learn about. They find this through websites, discussion forums, multiplayer games, mobile apps, and other online resources. Second, they learn about this content with the support of a community, as peers and mentors play, discuss, and collaborate with them, both online and offline. Over time, they begin engaging in construction of meaningful public entities or artifacts, from imagery to avatars to videos, and their constructions become steadily more sophisticated over time as they continually interact with content and the community. Finally, in most of these situations, they are also engaged in extensive writing or composition, on journals, blogs, wikis, fan fiction networks, and other sites.

Each of these four Cs also resonates with educational theory and research. The best schools are known for providing students the most diverse, rich, and differentiated educational content—for example, through well-equipped libraries (see, e.g., McQuillan, 1998). When students take content and use it to construct and reconstruct things, they are pushed to confront and overcome limitations in their own thinking and mental models and to use knowledge they are gaining in increasingly innovative ways (Papert, 1993). Communication and
support from others is vital for this process as it helps them advance through what Vygotsky (1978) calls a *zone of proximal development*, that is, the distance between what they can achieve when assisted by others and what they can achieve by themselves, and progress from being a peripheral to a more central member of a community of practice (Lave & Wenger, 1991). Finally, through extensive writing, they further sharpen their ideas (Black, 2008) while developing a vital skill for 21st-Century life (National Commission on Writing, 2004).

All of these functions can be carried out without computers, and top-notch schools have long worked to provide students rich individualized content, social support for learning from peers and mentors, and opportunities to construct or compose meaningful products. However, each of these functions can be amplified through the use of digital media. Digital technology provides access to a vast amount of interactive content; connects people across the classroom or around the world; allows for advanced design and construction in the arts, engineering, and other fields; helps learners write, receive feedback, revise, and publish their work for authentic audiences; and increases student autonomy and motivation (Chen, Fitzgerald, Petrova, Star, Taylor, & Dede, 2014). Let us then consider how these four critical functions can best be approached in a digital literacy framework.

**Content.**

Warschauer (2006) suggests three pedagogical strategies for promoting digital literacy through access to online content.

*Just-in-time learning.* The first strategy is emphasizing *just-in-time learning.* Cognitive scientists have long known that people learn best when information or instruction is provided at the point of need (see discussion in Gee, 2003). Teachers can exploit the potential of digital
media to enable this learning process in the classroom, as seen in this example from a primary teacher who began teaching with laptops:

The kids have so many questions and the computer just opens a brand new world. It used to be if a teachable moment arose, then “well, tomorrow we'll find out about that.” Now it's “OK, would you open your computer and let's go find out,” and we can take them right now and they get excited about it. Right now, we are doing a study on symbols of our nation. We go search the Statue of Liberty. We can take a virtual tour of the White House, or Congress, or the Supreme Court. They can go there and be a part of it. And they could not get out before. They had to rely on the books that were just meant for every student in every state across the nation (Warschauer, 2006, p. 87).

High school teachers can put the same principle to use, as seen in this example from a high school social science teacher in the same study:

I had a door totally open up to me in terms of culture, geography, current events, news, all of the things that I have been trying to get my students to learn from a textbook: language, what this sounds like, what that looks like, these five different cultures that live in one square mile, this civil war, that political situation. All these things that I've been trying to use, pretty much without my hands on, became literally at their fingertips. I would say from the first two years I was teaching Cultural Geography till now, they're learning something totally different than my students did in the first two years. We literally have a globe at our fingertips. That's the difference. I can make the Zulu tribe in South Africa come alive for them versus talking about these people that they've never seen,
they don't know, they can't grasp. And where I was using a newspaper article of the previous day's news to deal with current events, we can literally track an event hour by hour online and change the discussion minute by minute. It totally involves them one hundred percent in the news (Warschauer, 2006, p. 88).

*Individualized, differentiated, and personalized learning.* The second strategy is to promote learning that is *individualized* (according to learning pace), *differentiated* (according to individual learning preferences), and *personalized* (according to learners’ specific interests). This can be accomplished in numerous ways with digital media. First, reading material can be scaffolded, to provide additional support to students at different reading levels. For example, a software program called Liveink transforms digital texts into a cascading, poem-like format that breaks sentences into chunks that are intended to be easier to process enables students to read material above their grade level (Walker & Vogel, 2005). Other websites provide the same content at multiple reading levels (e.g., simple Wikipedia) or allow for searching to be sorted by reading level (Google). Digital texts can also be more easily made available in multiple languages, roughly translated on-the-fly, and packaged with glosses and audio pronunciation assistance (see Chun, 2011; Lundy, 2014, finding that not only did digital text support technology fluency, more sophisticated learning products, and a more supportive experience, but student and teacher preference, with evidence of academic benefits across a highly diverse student population). Students can also, of course, access individualized online tutorial software and be provided a menu of options to pursue, so that those with different interests or preferences or who work at different speeds can pursue different learning paths (VanLehn, K., 2011). Others have created methods to improve the efficiency of students reviewing material
for a test through personalized review via retrieval practice software (Lindsey, Shroyer, Pashler, & Mozer, 2014, finding a 16.5% increase in course retention). Instructors should note, though, that simply assigning students to work with individualized software is often ineffective, unless the activities they carry out are well integrated with broader classroom instruction and goals (see Cuban, 2006). In addition, creating strong interventions using technology is a difficult and iterative process (see Zhao, Englert, Chen, Jones, & Ferdig, 1999). Thus, many commercially available, pre-packaged options remain fairly limited.

Digital learning is supportive of shifting learning environments from teacher-centered to more constructivist, learner-centered approaches (Barbour et al., 2011; Ng, 2012; Twigg, 2001). For example, teachers can allow students to pursue information on topics of interest and work together to share their new knowledge with a partner, small group, or whole class (see Warschauer, 2006). Technology increasingly enables learners to gain knowledge and technological skills informally and to be connected to online communities. Teachers can more thoroughly address individual student needs and abilities in digital learning environments by making adjustments in the digital environment or content itself to meet the diversity of learners’ individual needs and abilities. For example, Universal Design for Learning (UDL), a set of principles for developing curriculum, creates flexible approaches appropriate for individualized learning contexts (Rose & Meyer, 2002). These principles emphasize multiple means of representation, expression, and engagement. Students can then use the resources that best meet their needs and objectives.

The UDL principles were well applied in the ICON (Improving Comprehension Online) study with 249 fifth graders over a school year (Proctor et al., 2009). While reading multimedia
texts, participants had easy access to the meaning of vocabulary words, which were represented via multiple modes, such as written, audio, and pictorial information displays. The participants were also encouraged to express themselves in multiple ways and were able to write or orally record their work. To engage more students, wide-ranging levels of support, choice, and multimedia were used. Participants’ personal experiences were considered in creating the curriculum. In comparison to a control group, there were significant intervention effects on a standardized measure of vocabulary knowledge.

Tutoring is another way of individualizing learning via technology. In a study that lasted for five weeks with two one-hour sessions each week, sixth-, seventh-, and eighth-grade students (N = 64) played ten selected games that were designed to follow the designated middle school math curriculum (Ke, 2013). A total of seven graduate students and teachers in participating schools (one rural, one urban school) were trained to serve as tutors. A small group of students were randomly assigned to a tutor in each gaming session. Tutees and a tutor were seated together before a desktop. While tutees generally controlled the mouse, tutors, as facilitators, answered questions, gave feedback between moves, prompted for explanations and encouraged tutees to continue working with confidence. Tutors provided help on both game play mechanics and game-embedded math concepts. Data were collected through in-field observation, content analysis of game-based tutoring–learning interactions, and an achievement test. Although there was an improvement in students’ state test performance at the rural school, the improvement was not statistically significant at the urban school. Tutoring students in the use of new software or other technology may be one way to foster the development of these skills as part of learner-centered environment.
**Student research.** A third strategy for promoting digital literacy is exploiting digital technology in pursuit of student research. Information literacy, or the ability to access needed information effectively and efficiently; evaluate information and its sources critically; incorporate selected information into one’s knowledge base; use information effectively to accomplish a specific purpose; and understand the economic, legal, and social issues surrounding the use of information is one of the most important aspects of digital literacy (American Library Association, 2000). These are partially dependent on traditional reading skills (see Leu, et al., 2014), but involve much broader reading skills in the digital mode, as well. For example, readers must navigate links, sample information, determine its relevance, and decide whether to go deeper or move back to the prior page as the negotiate online research (Leu, Kinzer, Coiro, Castek & Henry, 2013). Leu et al. (2014) define at least five processing practices that occur during online research: “(1) reading to identify important questions, (2) reading to locate information, (3) reading to evaluate information critically, (4) reading to synthesize information, and (5) reading to communicate information” (p. 1164). Nonetheless, access to online information allows students to find specialized information in their area of interest, no matter unusual or specific it is (Ito, et al., 2008).

Information literacy training can begin before students use their own computers. For example, librarians or teachers can work with students to develop research questions, identify keywords, search for information in library materials, critique sources, and complete bibliography forms where they write down correctly formatted citations and describe the information found. These are traditional research techniques that can be adapted to include digital sources. Students can be taught to critically examine sources of all types for quality,
conflicts of interest, logic, and usefulness. Students of all ages can be scaffolded in their research activities, for example, by being directed to pre-selected Websites rather than the open Web. In some cases teachers make use of specialized search engines for schools, such as NetTrekker or set up guided information-seeking activities called WebQuests (Dodge, 2005).

 Warschauer (2006) provides an example of a Grade 4 to 8 middle school in the U.S. with outstanding information literacy practices. Students receive information literacy training beginning in the fourth grade, and they gradually get involved in more sophisticated collaborative projects. By the time students enter seventh grade, they are making use of computer and the Internet for highly interactive forms of learning, as they work individually and in groups to define questions or problems, gather and analyze information and data, and develop high-quality products to present their findings.

 For example, to better understand the U.S. constitution in social studies class, students visit the Website of the Bill Of Rights Institute, where they find information on recent court cases involving key constitutional issues and select one of interest to them. The students then read both their case and the background information on it, develop an opinion about the case, and write an essay of their opinion, which they share and debate with their teacher and class. Students in mathematics classes carry out stock market projects, in which they select and research companies, simulate investments in stock, develop spreadsheets to track their earnings, and write reports incorporating their research and data analysis. And one time annually, an entire grade level comes together for a broad interdisciplinary collaborative research project, for example, looking at the industrial revolution and its relationship to Western expansion, technological progress, women’s rights, and slavery. Students worked
within one of these four areas to develop both a traditional essay and a multimedia presentation on their particular sub-topic and how it relates to the overall theme of progress (Warschauer, 2006).

Finally, students can take advantage of digital media to conduct more direct analysis of data, whether by looking at information online about their own communities, or gathering data from digital probes and microscopes related to temperature, voltage, light, force, motion, and chemical structure.

**Composition.**

Informational writing is one of the most powerful levers of student learning. Through writing, students learn the valuable skill of composing written content, develop their academic language proficiency, and gain experience in critical analysis and reflection on academic content. Writing using computers has been found to support more collaborative, iterative, and social processes compared to pen and paper writing (Goldberg, Russell, & Cook, 2003; Warschauer & Ware, 2008). Computers allow an ease of editing that pen and paper do not. Because of the ease of editing, students can edit iteratively with less work, colleagues can interject their contribution without requiring a full re-writing by hand, and commenting on another’s work is simpler and easier to read and incorporate into the finished product. For example, in writing this report, multiple authors contributed to the initial draft, a single author revised isolated sections to increase readability and provide a consistent voice, the audience at the IB provided both specific changes and comments or questions imbedded in the draft, and the final revisions could be incorporated efficiently into a legible document.
Students tend to be more engaged generally and to produce higher quality and increased quantity of writing using computers (Warschauer & Ware, 2008). In a meta-analysis on the effects of word processing on writing, Morphy & Graham (2011, see also MacArthur, 2006) looked at 27 studies with weaker writers, 20 of which were not considered in prior reviews. From 77 independent effects, the following average effects were greater than zero: writing quality ($d = 0.52$), length ($d = 0.48$), development/organization of text ($d = 0.66$), mechanical correctness ($d = 0.61$), motivation to write ($d = 1.42$), and preferring word processing over writing by hand ($d = 0.64$). Especially powerful, writing quality effects were associated with word processing programs that provided text quality feedback or prompted planning, drafting, or revising ($d = 1.46$), although this observation was based on a limited number of studies ($n = 3$). Research has also shown the benefit of computer-based writing development for students with learning disabilities (MacArthur, 2006), particularly when coupled with evidence-based, quality direct instruction.

However, Berninger & Abbott (2009) found that while the efficiency of transcription modes (pen vs. computer) depended on the level of language and grade, at the text level pen had a consistent advantage over keyboarding for both amount written and rate. This brings into question the frequent practice of accommodating students with learning disabilities by allowing keyboarding rather than handwriting and suggests benefits to instruction with both modalities.

Digital Is, an online program that is part of the National Writing Project (http://digitalis.nwp.org) is an open, community-driven knowledge base for resources and conversation about learning and teaching writing in an increasingly digital and interconnected world. The National Writing Project has more than 200 university-based sites working to develop programs and research to support writing teachers.
It should also be noted that assessments given via pen and paper might under-represent the skills of digital writers, which is part of the reason many assessments are moving toward computer-based forms of writing (Horkay, Bennett, Allen, Kaplan, & Yan, 2006; http://nces.ed.gov/nationsreportcard/tba/). Of course, the reverse is also true, computer-based assessments may underestimate the skills of students unfamiliar with computer-based writing—modality expertise is indirectly reflected in the achievement scores in both events (Horkay, et. al., 2006).

Social media can be particularly helpful in encouraging and supporting written composition. For example, the Young Writers Project (www.youngwritersproject.org) is a nonprofit dedicated to providing young writers a safe space and audience for their writing. Online environments provide an opportunity for writing in diverse genres, to diverse audiences, on interest-driven topics without geographic constraints. Online writing communities can support developing writers by providing substantive feedback, along with providing an authentic audience (Ito, et al., 2008). Even massively multiplayer online gaming supports literacy practices through in-game discussions, online game forums, and fan sites (Steinkuehler, 2007; see also discussion of fan sites and Black’s study with English learners, above). There has been little research published that considers the use of social media to develop writing in K-12 students, but some have studied adult learners and found the use of blogs to provide a way for students to scaffold one another using interactive features and collaboration or to support adult English learners (e.g., Bloch, 2007). Some teachers and parents, however, are cautious about using social media for fear that the writing skills will not be transferable to academic writing, that the media is distracting, and that there are privacy and other dangers involved in
unrestricted social media. Most of these concerns can be successfully addressed in a thoughtful curriculum. Students should be taught online safety as part of the digital literacy curriculum. Writing assignments that mirror academic writing as closely as possible should be encouraged, to increase transferability. Finally, students need to be taught how to minimize the distractions of the medium (through various programs, for example, that reduce distractions automatically, or through monitoring usage) as a life-long skill to managing their own digital environments.

Another digital tool worth considering is automated writing evaluation software. Students need a great deal of practice and feedback to become strong writers, but teachers are challenged to respond to student writing quickly given time constraints and student numbers. Automated writing evaluation uses computers to substitute for the teacher feedback, using various types of algorithms, grammar and spelling checks, vocabulary level, etc. Automated writing evaluation has been, as Warschauer calls it, a “fallible tool,” but used thoughtfully may provide some worthwhile feedback for a portion of student writing (Grimes & Warschauer, 2008; Zheng, Warschauer, & Farkas, 2013). For example, it can be used for some assignments, but not all assignments, or as a preliminary review for mechanical concerns. In addition, improvements in computing and artificial intelligence suggest promising developments in the future (see, e.g., the Revision Assistant under development at Lightside Labs--now a part of Turnitin.com, www.lightsidelabs.com). Like the use of peer review, the teacher needs to ensure that the feedback is useful, supportive, and relevant to the students at hand.

Warschauer, et. al (2011; Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014) provide case studies of two districts that successfully boosted both “traditional” literacy and new digital literacies through an emphasis on information writing with digital media. Littleton Public
Schools in Colorado organized a curricular reform with technology called “Inspired Writing,” which provided laptops to all students in grades 5 to 10. Beginning in upper primary grades, students spend about an hour a day on writing, with a focus on learning to write for authentic audiences and purposes. The first portion of the hour dedicated to direct instruction, the second to drafting and editing, and the third to publishing and sharing. Individual student laptops are critical to the second and third stage. Students conduct all their writing on Google Docs, to facilitate both collaborative writing and feedback. They also take advantage of blogs and wikis to publish their writing for authentic audiences, both in the same school and across the world. Analysis of student contributions to a district-wide blog indicated that they found many benefits to the laptop program, including more efficient and productive learning, use of tools for better writing, improved access to information, higher engagement with new media, remaining relevant in a technological world, and sharing and learning from peers (Zheng, Arada, Niiya, & Warschauer, in press). Studies also found that that program, plus another similar program in a California district, helped low-income Hispanic students close the literacy achievement gap with their typical peers (Zheng, Warschauer, & Farkas, 2013).

Construction.

In the age of digital media, written texts are not the only important medium of communication. Rather, computers can be used to create a wide range of artifacts, important for learning and interaction. The vast creative tools of computers in areas such as programming, robotics, and computer-assisted design are beyond the scope of this report. For now we focus more specifically on multimodal communication through, for example, digital photography and audio/video production.
Warschauer’s 2006 study of multimodality in the classroom indicated five successful strategies for fostering digital literacy learning, which he labeled *resemiotization, persuasion, genre, and reflection*. *Resemiotization* involves the shifting of communicating or interpretive material across modes, allowing learners to take a fresh look at a message and explore it from an alternative lens. Some digital literacy scholars use the phrase “remix” from the music world for this concept. Students in a literature class can set the mood to a poem by creating an image and a brief musical interlude to accompany it. They can advertise a novel that they have read by creating a movie trailer for the film based on the book. Or they can interpret a medieval play through an online newspaper, with events, sports, and business, and comic sections all expressing or commenting on material from the play.

*Persuasion* projects might involve critiquing the persuasive use of media and developing multimedia that debunks false claims. For examples, junior high students can find and critique advertisements for unhealthy products and develop their own multimedia posters that include examples of those advertisements and counterpoise them with factual information. They can also produce their own persuasive presentations, for example, explaining why a particular country, or planet, is a good candidate to host the Olympics. Developing their own marketing material can help students develop a critical eye to the persuasive power of multimedia.

*Genre* projects emphasize helping students master particular multimodal genres, such as digital stories or documentary films. As with written genres, this involves showing students actual and multiple exemplars of the genre at hand (rather than, for example, idealized forms); drawing students’ attention to the way that authors make choices (in both content and form) to accomplish their purposes within a genre; and then providing students plenty of opportunity to
plan, compose, and edit their work while receiving critical feedback from peers and the instructor.

*Reflection* projects engage students in recording and reflecting on their own performance. Foreign language students, for example, can video record their speeches from the beginning, middle, and end of the semester to learn about needed areas of improvement and take note of their progress. Industrial arts students can video record what happens to a wood bridge they have built when they place a brick on it, as playing the recording back frame by frame will reveal exact areas of weakness. As seen in the example of King Middle School below, teams of students can also help create video documentaries of major group projects; the documentation provides a highly motivating digital literacy initiative for the team involved, while also creating a long-term memento for the whole class and their loved ones.

Technology also provides opportunities for students to construct knowledge in class, which may be otherwise difficult in traditional settings. An example of this knowledge-centered approach is the *flipped learning model*, in which classroom time is devoted to more inquiry-based projects and students watch teacher videos with lecture content for homework (Beach, 2012). The ability to easily record and playback recorded content allows teachers to provide customized content to their classroom for consumption during out-of-school hours, creating time during the class day for in-class activities focused more on construction. This learning model inverts common practice of instruction in which the lower end of Bloom’s cognitive taxonomy (e.g., remembering, understanding, or applying) is lectured in classroom and the higher end (e.g., analyzing, evaluating, or creating) is assigned as homework (Sams & Bergmann, 2013). Lectures and direct instruction, which require a large quantity of
remembering and understanding, are removed from classrooms and are given to students as video resources. Therefore, classroom time is repurposed and used for collaborative work or focused direct instruction on misconceptions or difficulties.

Studies report the benefits of the flipped learning (Rutherfoord & Rutherfoord, 2013; Sams & Bermann, 2013), which attempts to implement four characteristics of effective learning practices. First, this learning model supports knowledge-based learning as in-class time focuses on higher levels of cognitive activities, which may not be done individually. Students can gain assistance as well as inspiration from interaction with teachers and peers. These activities include creating, evaluating, and analyzing. Secondly, this learning model makes student-centered learning possible by enabling students to learn at their own pace via a library of instructional videos available for repeated viewing and review. This self-paced model of instruction might be especially important for addressing the needs of diverse classrooms. Community-based learning also takes place. While students work either independently or in a small group on classroom activities, the teacher has an opportunity to provide customized help or feedback to students about their understanding. The teacher is also able to modify instruction for each student as needed. Lastly, ongoing assessment accompanies the learning process in this model. Students come to class with questions about the materials they did not understand while they watched
the lecture materials. They then have an opportunity to correct misconceptions during face-to-
face interaction in classes.

Since Jonathan Bergmann and Aaron Sams implemented this approach at a high school in Colorado, this method caught on quickly in K-12 settings across the U.S. The overall performance of students in flipped classrooms was notable (Rutherfoord & Rutherfoord, 2013). For example, Clintondale High School in Detroit had a 33% decline in failure rates in ninth-grade English and a 66% decline in over-school discipline rate for ninth graders after the adoption of the flipped classroom model (Beach, 2012).

Bergmann and Sams (2013) shared successful cases in foreign language, mathematics, and science classes from their school. For example, they describe a Spanish class that consisted of three groups of students with different proficiency levels. A teacher was able to make effective use of in-class time when she had to teach all three groups at the same time. In class, students selected works that were appropriate at their level (e.g., grammar, conversation, or assignments in the learning management system); the teacher moved around the room and offered students direct instruction as they needed it. In mathematics classes, some teachers used videos to pose questions to students, who had to develop answers on the basis of what they saw. Other teachers created instructional videos to familiarize students with content that was a prerequisite for a future class. A chemistry teacher used project-based learning, in which his students in the U.S. collaborated with students in Canada to learn concepts about solutions, acid and base chemistry, and the mathematical analysis involved in the analytical process. The students in his flipped classroom started with a problem to solve instead of the teacher’s
lecture. The students watched the instructional videos or received selected resources when they needed information.

The common classroom practice in Singapore is blended learning, the combination of online and face-to-face learning, rather than online learning only or distant learning (Barbour et al., 2011). Online learning in Singapore is used to support the face-to-face learning in classroom. Teachers are required to develop online teaching skills, which they learn in the professional development program provided by the National Institute of Education or professional development organizations. Although the government provides baseline guidelines for professional development, there is no prescribed set of qualifications or training that a teacher must engage in to teach online. Teachers receive continuous support for pedagogical use of ICT from the selected peers named “ICT Mentors” in the same schools.

Ongoing teacher development will be needed to prepare teachers to create online content. In reporting on an early workshop for practitioners and researchers from the United States, the United Kingdom, and other European countries, Goodyear, Salmon, Spector, Steeples, & Tickner (2001) discuss the competences for online teaching. They define the roles of an online teacher to include process facilitator, who facilitates the range of online activities that support student learning; adviser-counselor, who works with learners on an individual basis to get the maximum out of the course; the assessor, who provides grades and feedback to the students; content facilitator, who helps students understand course content; the technologist, who makes technology choices that improve the learning environment; the designer, who creates curriculum; and manager-administrator, who gets the students their accounts, keeps records, and ensures privacy (Goodyear, et. al., 2001; see also Wilson & Stacey, 2004). The tasks
of the process facilitator include familiarizing students with the online environment, establishing ground rules, creating community, managing communication, and modeling appropriate online behavior (Goodyear, et. al., 2001). These concepts have been used as the basis for designing certificate programs and to provide the framework for necessary teacher development (Wilson & Stacey, 2004). Strategies for helping teachers develop these skills range from online trainings to local peer support, depending on the needs and resources of the school and competency level of the staff (Wilson & Stacey, 2004). In order to be strong online, as well as in person, teachers need to know how to structure appropriate levels of challenge, ensure active participation by all students, keep the course content and discussions on track, adapt the content and delivery to address learner differences, create a safe and welcoming community, encourage and motivate students, and generally create a student-centered environment both online and off (Goodyear, et. al, 2001). Many of the skills required are necessary in both online and offline environments, but the changes in modality must be practiced—for example, keeping a classroom discussion on track requires different classroom management techniques than keeping on online discussion on track. Thus, although the overarching goals are the same, they differ in technical specifics.

**Community**

Community refers to the ability of digital media to bring students together—with each other, with partners in other classes and schools, and with adult mentors. This can occur through both online and offline interaction. Digital learning environments provide various ways of building learning communities and thereby facilitating collaborative activities, which may lead to improved student-learning outcomes (Rosatelli & Self, 2004; Ng, 2014). Tools for sharing
and constructing knowledge include online discussion forums, social networking, bookmarking sites, annotation tools, blogs, and wikis. Research suggests a number of recommended pedagogical strategies and practices.

First, a number of studies suggest the power of computer-mediated conversation, including among learners in the same school. Computer-mediated conversation can be powerful because it combines the interactive functions of speech with the archival functions of writing. Students can read and reflect on the comments of others, and refer back to them both as models and for critical response—yet they can still respond quickly in a highly interactive way. This can provide a powerful means of developing students’ academic language and critical thinking abilities. It has been especially valuable for second language learning purposes, as demonstrated in Lin’s (2014) review of dozens of studies on the topic. According to a survey of K-12 teachers using blogs in their instruction, such tools can enable the communication and collaboration necessary for building learning communities within the classroom (Felix, 2008). Since these tools or applications are not only available on computers but also on smart phones or tablets, they foster widely available synchronous communication and collaborative work. As an example of community-centered learning, English language arts teachers can employ digital tools for collaborative construction of knowledge in improving literacy practices of students. In a study with two seventh graders who read online texts, students were not only able to access the same text, but also to share reading strategies with each other (Coiro, Castek, & Guzniczak, 2011). These students used their own comprehension strategies, which differed from each other’s, but also had a chance to learn and try the strategy employed by their partner. There was another study of a literacy community in which 37 fifth-graders developed
cognitive skills through interaction (Park, Zheng, Lawrence, & Warschauer, 2012). This interaction was supported by synchronous online discussions using a web-based blogging tool for student and teacher interactions. The interaction encouraged students to use reading strategies such as simple and in-depth clarification and inference making. These skills were assessed through comparative analysis of students’ online postings from the beginning and end of the school year.

Cross-cultural partnerships between students and classes in different countries also provide a powerful learning mechanism since learners are often required to take a fresh look at their own culture when attempting to define or explain it for other cultures (Cummins & Sayers, 1995; Cummins, 2008). Again, many examples exist in the realm of foreign language learning (for a review of studies, see Kern, Ware, & Warschauer, 2004), such as a fascinating study about an exchange between learners of French in the United States and learners of English in France—almost all immigrants or children of immigrants who discussed and compared the immigrant experience in the two countries (Kern, 1996). Social studies, world history, and related fields also benefit from the access to rich multimedia content, original sources, and people around the world.

Digital media provide abundant opportunities for students to connect with mentors or specialists. This can occur through one-off interactions, for example, students in California using Skype with a soldier in the Middle East to get a first-hand account. It can also occur through

One example of a low-cost implementation of cross-cultural partnerships is the TeachersFirst XW1W (Across the World Once a Week) project, where users across the world answer simple questions, such as “Who does the dishes in your house?” or “How far do you travel to celebrate holidays?” on social media, whether tweets, blogs, wiki pages, or multimedia presentations and use the hashtag #XW1W to share their thoughts. See http://www.teachersfirst.com/xw1w.cfm?utm_source=TF+Update+- for details.
establishment of more formal mentoring relations, in which experts in different fields agreed to read or judge students’ work, or advice them on career paths. Youth can also connect with peers outside their own geographic community around areas of interest (Ito, et al., 2008).

Finally, collaborative work among students in a class and school using digital media can be an invaluable way of leveraging community for learning.

These last two forms of community building and engagement for learning are perfectly illustrated in Warschauer’s (2006, 2011) case study of King Middle School in Portland, Maine. King, which serves the most ethnically, linguistically, and economically diverse population of any school in Maine, has re-organized its entire instruction on a model called Expeditionary Learning. All students are grouped into “houses” of about 60 learners and four main teachers, with the teachers in each house having broad autonomy over class scheduling. The houses developed highly flexible block scheduling, with classes meeting for different lengths of time on different days, with ample time built in for teacher collaboration. Most importantly, most of the academic work in the houses and school was integrated into 8- to 12-week interdisciplinary collaborative research projects. These projects, called learning expeditions, are supported by students’ individual access to laptop computers.

Learning expeditions involve community projects that require students to do original research and create high-quality products for audiences beyond the classroom. The approach seeks to develop critical thinking and problem solving as elements of deep learning that prepares students for success in college and beyond. Emphasis is also based on creating a school culture based in strong adult-student relationships and positive character, with rigorous
expectations for behavior and achievement. Students in learning exhibitions have the opportunity to try on different professional roles and work closely with adult mentors.

Students in expeditions contribute to a comprehensive final product that requires each learner to create representations of the targeted knowledge and skills via both high-quality writing and craftsmanship. Student creation of art or multimedia thus always complements writing, rather than replacing it. All student writing done for the final product goes through an extensive review process, including self-editing, peer editing, teacher editing, and multiple revisions, giving low-performing students numerous opportunities to improve their work. The final product is multi-tiered, so that students who need extra support to produce their required portion can receive it while more advanced students can take on additional responsibilities related to research, editing, or multimedia production. Staff specialists in English language learning, special education, and basic literacy collaborate with the teachers to provide differentiated learning resources, experiences, and instruction that match the interests, abilities, and needs of all students, including multiple anchor texts, multiple students roles in the expeditions, and varied learning activities, a level of individualization that is greatly aided by personal laptop access. Extensive and flexible use of digital media for research, writing, and multimedia production, especially individual student laptops and online resources, but also digital cameras, camcorders, and a small number of desktop computers equipped with specialized software, helps ensure that students develop technological skills to complement their academic ones. Finally, culminating events that include the exhibition of student work and a multimedia narrative of the expedition produced by students allow students important opportunities to showcase their work to family members and the community.
In one recent exhibition, students interviewed Maine residents who were active in the civil rights movement, conducted research from primary documents of the era, and collectively wrote a 200-page book that they called *Small Acts of Courage*. A student-produced website on the project includes a downloadable copy of the book, photos, a video of the culminating event, and an additional five-part video that documents the students’ learning process. The latter video explains the detailed steps that students went through to convert interviews to stories, from review rubrics, to guided editing of other interviews, to collective analysis and scoring of model stories, to drafting, peer and teacher editing, to final publication. In a second recent exhibition, King partnered with university biologists to help students take soil samples from local farms and analyze the bacteria they contained. Working with community graphic artists, each student produced a pamphlet about particular bacteria that included both a written description and original artwork. In a third expedition, called Creating Currents, students investigated ways to reduce their carbon footprint through energy audit data collection and subsequent analysis leading to informed conservation practices. They also investigated alternative energy production and public policy decisions involving alternative energy, and collaborated with experts in the areas of conservation, building products, design, and alternative energy to create a green building design. The expedition culminated with a competition of electricity generating wind turbines built by the students.

King has developed an excellent overview that shares key steps for organizing successful learning expeditions (http://king.portlandschools.org/files/onexpedition/htm). One key lesson, from King and elsewhere, is that successful learning communities do not emerge on their own, but require extensive set-up and scaffolding by instructors. This is seen, for example, in the
research on Network Science projects, discussed in the professional development section below.

**Measurement of digital literacies.**

Another area of research has explored whether and how digital literacies can be measured across students. Educators can leverage both summative and formative assessments to evaluate student digital literacy practices. While frameworks often describe possible assessments for digital literacies, guidelines are often vague, encouraging “authentic” evaluation of students’ abilities (cf. summary in Dede, 2009). Potential specific assessments of students include activities such as digital portfolios, collaborative projects, peer assessments, online tasks, and use of automated evaluation software.

The New London Group acknowledged as early as in 1996 that assessments in new learning environments should be different from those in traditional curricula (Cazden, et al, 1996). For example, while most traditional assessments required learners to replicate general ideas or principles they were explicitly taught, new types of assessment need to be situated and contextualized. The learning processes of multi-literacies that the New London Group suggested, such as situated practice, critical framing, and transformed...
practice, will help define these new, contextualized assessments. The results of such assessments will in turn reformulate the learning process. Indeed, when Twigg (2000) gathered together a group of innovative virtual educators to discuss paradigm changes in online learning, their overall conclusion was that individualization, which they termed personalization, was the key to innovation in distance education. Twigg thus argues that quality online learning should include initial assessments of students’ knowledge and skills, individual study plans involving an array of interactive learning materials, and built-in, continuous assessment with instantaneous feedback. The International Association for Online K-12 Learning, iNACOL, further explains the importance of personalized learning (see www.inacol.org for discussion papers).

Table 3.2
iNACOL Elements for Designing Learning

<table>
<thead>
<tr>
<th>Element</th>
<th>Description of Element</th>
<th>Element’s Supporting Research</th>
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<tr>
<td>Active involvement</td>
<td>Learning requires the active, constructive involvement of the learner.</td>
<td>Elmore, Peterson &amp; McCarthy, 1994; Piaget, 1978; Scardamalia &amp; Bereiter, 1991</td>
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<td>Social participation</td>
<td>Learning is primarily a social activity and participation in the social life of the school is central for learning to occur.</td>
<td>Brown et al., 1996; Collins, Brown &amp; Newman, 1989; Rogoff, 1990; Vygotsky, 1978</td>
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<td>Meaningful activities</td>
<td>People learn best when they participate in activities that are perceived to be useful in real life and are culturally relevant.</td>
<td>Brown, Collins &amp; Duguid, 1989; Heath, 1983</td>
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<tr>
<td>Relating new information to prior knowledge</td>
<td>New knowledge is constructed on the basis of what is already understood and believed.</td>
<td>Bransford, 1979; Bransford, Brown &amp; Cocking, 1999</td>
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<tr>
<td>Being strategic</td>
<td>People learn by employing effective and flexible strategies that help them to understand, reason, remember, and solve problems.</td>
<td>Mayer, 1987; Piirpasc &amp; Brown, 1984; White &amp; Frederichson, 1998</td>
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<td>Engaging in self-regulation and being reflective</td>
<td>Learners must know how to plan and monitor their learning, how to set their own learning goals and how to correct errors.</td>
<td>Brown, 1975; Bransford, Pintrich &amp; Zeidner, 2000; Marion &amp; Booth, 1997</td>
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<td>Restructuring prior knowledge</td>
<td>Sometimes prior knowledge can stand in the way of learning something new. Students must learn how to solve internal inconsistencies and restructure existing conceptions when necessary.</td>
<td>Carretero &amp; Voss, 1994; Entwistle, Gagne &amp; Tisheron, 1983; Schonbein, Vosniadou &amp; Carrete, 1999; Vosniadou &amp; Brewer, 1992</td>
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<td>Aiming towards understanding rather than memorization</td>
<td>Learning is better when material is organized around general principles and explanations, rather than when it is based on the memorization of isolated facts and procedures.</td>
<td>Halpern, 1992; Reznick &amp; Klopfer, 1999; Pons, 1992</td>
</tr>
<tr>
<td>Helping students learn to transfer</td>
<td>Learning becomes more meaningful when the lessons are applied to real-life situations.</td>
<td>Bruner, 1993; Bransford, Brown &amp; Cocking, 1999; Bransford, 1997</td>
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<tr>
<td>Taking time to practice</td>
<td>Learning is a complex activity that cannot be rushed, it requires considerable time and periods of practice to start building expertise in one area.</td>
<td>Bransford, 1979; Chase &amp; Simon, 1973; Coles, 1970</td>
</tr>
<tr>
<td>Developmental and individual differences</td>
<td>Children learn best when their individual differences are taken into consideration.</td>
<td>Case, 1978; Chen et al., 1998; Gardner, 1991; Gardner, 1993</td>
</tr>
<tr>
<td>Creating motivated learners</td>
<td>Learning is critically influenced by learner motivation. Teachers can help students become more motivated learners by their behavior and the statements they make.</td>
<td>Dweck &amp; Ryan, 1985; Dweck, 1989; Lepper &amp; Hodel, 1981; Spaulding, 1992</td>
</tr>
</tbody>
</table>

Hargittai (2002) developed a survey-based measure of web-based skills in which individuals can rate their knowledge of various web terms (such as URL or bookmark); this approach has been found to be more effective as a measure of digital literacy than asking participants to self-rate their overall digital literacy (Hargittai, 2005). Scores on these measures of digital literacy correlate with education level (Hargittai & Hinnant, 2008). Although these measures seem to be successful in identifying inequalities in prior education and web-based knowledge, they were designed for empirical research and not for classroom use. Standards such as those promoted by the International Society for Technology in Education (ISTE) for teachers, students, and administrators, may also be useful for measuring digital literacies (www.iste.org.standards) and have more of a classroom focus. For an additional discussion of assessments, particularly those focused on assessing teachers and curriculum, please refer to our section on the use of frameworks, “What is the Role of Technology Integration Frameworks in Promoting Digital Literacies?” below. For a discussion of the proper types of assessment and technology’s role in improving assessments, see Schwartz & Arena (2013).

**How to assess.** The new paradigm of digital learning requires assessment models that are different from those in traditional learning environments. For example, more and more automatic evaluation tools are emerging to evaluate digital (and traditional) literacy practices, particularly the creation of digital texts. Automated writing evaluation (AWE) software has been proposed as one way to enable students to receive more feedback on their writing (see the discussion of AWE, above, under “Composition”). The use of such tools may motivate students to write more; however, teachers may prefer pen-and-paper evaluation methods, and current software algorithms lack the sophistication to capture and rate tone or voice (Grimes &
Warschauer, 2010; Rivers, Whitelock, Richardson, Field, & Pulman, 2014). These evaluation tools nevertheless may simplify and streamline assessments and act as a supplement for teacher and peer feedback on digital work.

In the United States, assessment strategies have also emerged in connection with the Common Core State Standards. The Online Research and Comprehension Assessment (ORCA) Project is a project aimed at “developing valid, reliable, and practical performance-based assessments of students’ ability to conduct Internet research in science and write a short report of their results” (Leu et al., 2014, p. 226). Students are provided with scenarios and must use a variety of digital resources including blogs, email, and search engines to produce research. This method of assessment, which enables students to be evaluated on their digital literacy skills within an environment that closely mimics authentic practices, could be adapted to test other specific digital skills such as media production and information literacy. The CCSS, however, are by no means the only way US educators have attempted to address digital literacy among students. Many programs and curricula have been explored as ways to promote these skills. Within digital learning environments that promote individualized and cooperative learning, one of the issues concerning assessment is how a teacher can assess student achievement either individually or in groups or both. As digital learning environments are framed as being learner-centered, students’ participation in assessment processes appears fair (Chang & Chen, 2009). Since a teacher cannot observe students’ interactions all the time in a digital learning environment, studies suggest alternative assessment methods such as self-, peer-, and collaborative-assessment (Chang & Chen, 2009; Gogoulou et al., 2007).
Peer assessment may be particularly beneficial for the assessors, as it provides students with opportunities to reflect on their own understanding of content and product quality (Zariski, 1996). Like automated evaluation software, online peer assessments can also be a way to “crowd source” feedback, enabling students more opportunities to revise their work (e.g., Shih, 2011; Keppell, Au, Ma, & Chan, 2006). However, many studies caution that peer assessments should not be used as a replacement for teacher evaluations and that the peer assessment process must be highly scaffolded for feedback to be useful (Falichov & Goldfinch, 2000; Wen & Tsai, 2006) and to maintain a safe learning environment.

As another example of a peer-assessment method, Chang and Chen (2009) proposed a Fuzzy Peer Assessment System (FPAS). This method not only meets the requirements of collaborative learning but also allows all students to participate in all phases of the assessment processes. This system is divided mainly into three phases. To begin with, the teacher and students jointly establish an assessment questionnaire, which helps the students evaluate peers’ performance and participation in group work. In this phase, students rank their preferences for assessment criteria. The FPAS also allows teachers to assign different weight to elements and questionnaire items, because teachers have the requisite expertise and knowledge of the goals for the course. In the second phase, students complete peer assessments using the questionnaire. In order to construct a decision matrix, the FPAS uses consistent fuzzy preference relations. Based on the results of the constructed peer assessment questionnaire, the FPAS outputs a score for a student’s contribution.

Portfolios are another way to assess students’ digital literacy. Portfolios can take on many different forms, with Paulson and colleagues (1991) defining one as “a purposeful
collection of student work that exhibits the student’s efforts, progress or achievement in one or more areas. The collection must include student participation in selecting contents, the criteria for judging merit, and evidence of the student’s self-reflection” (p. 60). Portfolios have been used in subjects overlapping with digital literacy, such as information literacy, with benefits to student understanding and teacher efficiency found (Sonley, Turner, Myer, & Cotton, 2007). Barrett (2007) indicates that digital portfolios in particular include processes such as reflecting, collaborating, and making connections across texts (p. 439). As students engage in these processes to collect artifacts of their work, the portfolio might serve not only as a summative assessment of their learning but also as a way to learn through reflection. Additionally, portfolios can also be collaborative; students can work together to compile evidence of their coursework.

Project-based collaborations are another way to assess digital literacies. Bruce (2009) used a yearlong digital video production project as a way for students to develop composition skills. He found that students engaged in a process of video editing that involved peer teaching as they learned camera and editing techniques and frequent self-evaluation and revision as they composed their videos. He argues that video work might expand students’ composition processes; students may be more motivated to complete video projects than long-term writing projects, and video composition requires the skill to manipulate textual, temporal, audio, and visual elements that can apply to other subjects such as writing. Wikis, or collaborative online resources, are another example of a possible collaborative project for assessing digital literacies.
In Forte and Bruckman’s (2007) design, high school students contributed to an online, public wiki; this assignment replaced what would have been a traditional research paper. While this assignment served as a way to assess their knowledge of a particular topic, it also served as a way for students to explore and analyze digital literacy practices. Students grappled with the idea of genre and how writing and citing sources for an online space varies from a traditional paper; however, this research suggests that explicit rubrics and discussion of requirements is key when using nontraditional assessment methods. For example, one student said, “it’s been difficult, not horrible, because we don’t really know exactly what our requirements are” (Forte & Bruckman, 2007, p. 31). Digital tools such as Google Docs can also provide a space for students to collaborate simultaneously on writing and research; students can develop collaboration skills while producing work for assessment (Blau & Caspi, 2009; Herrick, 2009). The final product of multimodal projects such as videos, wikis, and blogs can be assessed based on use of skills that students develop over the course of production, such as composition, editing, voice and expression, and research.

Gogoulou et al. (2007) examined self-, peer-, and collaborative-assessment activities within individualized and collaborative learning environment in the study with 35 students for nine weeks. While participating in these three forms of assessments, students were expected to be inspired by peers’ work, to develop such skills as critical thinking, teamwork, self-monitoring and regulation. To accomplish this, the authors used the Peer- and Collaborative-ASSEessment Environment (PECASSE), which is available at http://hermes.di.uoa.gr:8080/pecasse. Initially students submitted their work and they were responsible for evaluating their own work based on specific criteria (self-assessment). They were then assigned two activities to review and
provide feedback on: one on the same topic as their own and the other on a different topic (peer- and collaborative-assessments). This evaluation was submitted via an assessment form. As the next step, students received two anonymous reviews of their activity. Students then evaluated the quality of those reviews. This feedback also helped students revise the work that had been submitted in the first step. The participants rated positively the capability of the automatic assessment environment, PECASSE, and the provision of immediate informative feedback on their work.

In all of these assessment methods, the need for student-, rather than teacher-, centric work is key. Digital literacies include the skills for “locating and acquiring knowledge independently; wise use of knowledge to solve problems; informed choice and critical evaluation...and communication and collaboration” (Eyal, 2012, p. 42). In order for students to develop these skills, assessments must recognize and reward this independent thinking and working. In the next section, we discuss in more detail the types of pedagogical strategies for promoting these skills and mindsets among students.

**What to assess.** In addition to the issues of “how to assess,” we also need to contemplate what types of skills and literacy should be included in assessments, in order to design assessments appropriate to digital learning. First of all, new assessments need to be developed to measure outcomes of technology-rich experiences, which are hardly reflected in such old types of assessment as multiple-choice questions (Brown, Lockyer, & Caputi, 2010; Katz, 2013). As warned by Rowsell and Walsh (2011), technical skills of using digital technologies may be overemphasized in assessing students’ digital learning. To avoid this possibility, they suggested that it is necessary to distinguish between the technical skills of
operating digital equipment and software tools. Loureiro, Messias, and Barbas (2012) categorized kinds of skills or knowledge that are needed to promote digital literacy learning: e-skills, e-literacy, and soft skills. Students should develop e-skills that denote skills needed to operate digital devices and services, e-literacy that refers literacy competence to understand and acquire knowledge by using such digital services, and soft skills abilities to interact and cooperate with others when constructing meaning (soft skills).

Similarly, Calvani et al. (2008) proposed three dimensions of abilities and the integration of three dimensions to be assessed: technological, cognitive, and ethical dimensions. For the technological dimension, students need to employ skills in a flexible way to explore problems in new technological contexts. The cognitive dimension denotes being able to read, select, interpret and evaluate data and information taking into account their pertinence and reliability. While using technologies, students should also be ethical and responsible for using technologies and interacting with other individuals. Each dimension corresponds respectively to e-skills, e-literacy, and soft skills.

Wiggins and McTighe (2007) suggest that classroom teachers focus on what they call cornerstone assessment tasks, that is, worthy authentic performances that are reflective of the key challenges in the subject. They provide examples of such challenges, most of which involve sophisticated uses of digital media, in a number of disciplines:

- In science, the design and debugging of significant experiments;
- In history, the construction of a valid and insightful narrative of evidence and argument;
- In mathematics, the quantifying and solving of perplexing or messy real-world problems;
- In world language, the successful translation of complex idiomatic expressions;
• In communication, successful writing for specific and demanding audiences and purposes; and
• In the arts, the composing/performing/critiquing of a sophisticated piece (pp. 42–43).

McTighe and Seif (2010) help deconstruct the distinguishing qualities of these kinds of cornerstone task. First, they reflect genuine real-world accomplishments and are set in authentic contexts. Unlike items typically found on standardized tests, they are contextualized in a real or realistic situation. Second, they require students to apply their knowledge and skill to new situations. By requiring such transfer of student learning, they provide a measure of in-depth understanding, while also reinforcing to learners that a major goal of education is to be able to use what is learned in the wider world beyond the classroom. Third, they naturally integrate 21st-century skills with the big ideas of academic content. They call for genuine applications of thinking (e.g., through creative problem solving), technology use (e.g., to find and critically evaluate information), communication (in writing or other media), opportunities for collaboration with peers, and habits of mind such as persistence. And, finally, they can recur across grade levels, in increasingly sophisticated forms. For example, whereas elementary school students might be asked to interpret the data on height for their 2nd-grade class and prepare a chart for the 1st-graders that helps them understand how students change from 1 year to the next, high school students can be asked to interpret the data on the spread of the HIN1 infection on each continent over 12 months and prepare a Website, podcast, or newspaper article for a public audience that explains spread rates in relationship to seasonal variation, international travel patterns, and government policies.
How Can Teacher Education and Professional Development Promote Digital Literacies?

Thus far, our discussion has addressed conceptual frameworks and pedagogical strategies for implementing digital literacies in the classroom. When putting these ideas into practice, however, teacher education and professional development are vital; educators face many challenges when teaching digital literacies and require ongoing training and support. IB schools strive to be at the forefront of educational leadership, which requires investment in the teachers on the front line. We first review how digital literacies and the push for technology use in the classroom might alter the role of teachers. Next, we describe suggestions for preparing teachers to use these technologies and pedagogical strategies within the classroom.

Changing notions of literacy and the role of teachers.

In a study conducted by Jacobson et al. (2010), a 187-item survey administered to a total of 1605 teachers and interviews to a total of 103 administrators and teachers in Singapore. The findings revealed the relationship between teachers’ beliefs about knowledge and learning, their pedagogical practices, and uses of technologies. First, teachers’ beliefs about absolute knowledge were positively associated with their beliefs about transmissionist pedagogies, traditional assessments, the usefulness of standardized assessments, and the use of teacher-centered methods, but not student-centered approaches. Second, teachers’ preference for a particular pedagogical approach seems to depend on context. For example, a teacher-directed approach was generally used in math while a learner-centered approach in language arts and social studies. Third, technology in teacher-centered instruction was used for retrieving information and showing multimedia resources (e.g., animation, pictures) to students. In such classes students were given tasks requiring ICT-related skills and were trained to use them. On the other hand, technology used in learner-centered instruction included blogs and quest, simulation, project-based learning, and concept mapping programs.

The ubiquitous presence of new technology has brought significant changes in discourse practices and literacy education. New digital genres and new forms of discourse are constantly emerging, generating new discourse practices, norms, and communicative processes. In school contexts, teachers need to be digitally literate in order to empower students with the skills and knowledge that they will need to be successful in a workplace dominated by technology (Pianpatti, 2001). There has been a strong call for teacher education to actively
engage teachers in learning about and analyzing technology and media, particularly those used by their students (Cervetti et al, 2006). The central role of teachers in integrating technology and transforming it to learning has long been emphasized (Office of Technology Assessment, 1995; Trotter, 1999).

It has been widely assumed that a technology-enhanced curriculum may work best with teachers as facilitators. For example, an evaluation of the Maine Learning Technology Initiative (MLTI), a U.S. state-wide program that provides wireless laptop computers to all seventh- and eighth-grade students and teachers, have revealed that teachers have begun to see themselves as partners in learning with students. Teachers reported having a more “reciprocal” relationship with students; students were responsible for their learning process and teachers served to monitor and guide the students (Fairman, 2004).

It should be noted, however, that the teacher’s role as facilitator is not of reduced or minimized importance as learner autonomy increases. Rather, the teacher’s role remains critical, just shifting in modality and specific strategies, but the themes remain the same. The teacher must determine context-appropriate instructional strategies to fit the students in his or her class and their learning needs, such as by combining direct instruction with facilitation or providing video or interactive content to reinforce class activities. The teacher must also bring appropriate class management structures to a dynamic class environment and retain authority while providing autonomy.
Putting it all together: Distance learning in Australia

Australia has a strong national interest in and support for digital learning. Technology integration initiatives, funded by national and local governments, emphasize that all teachers and students are expected to make use of evolving technologies, placing a priority on digital literacy (Barbour, 2011). For example, the initiatives require that teachers use educational technology, digital resources, and tools provided for classroom use. As expertise in digital learning is required for teaching, teacher education courses that all teachers must have completed include ICT-related units. The digital resources are provided in a national collection of digital content resources and technology infrastructure. Students are able to learn any subjects online. The national curriculum mandated for Prep-Year 10 has been made available in electronic format. Along with curriculum, resources and materials can be also delivered electronically. Students are therefore able to take courses that are not assigned in their schools.

It is no wonder that the dominant teaching paradigm in Australia is described as 21st Century learning with a great focus on ICT use. We can gain insights on effective teaching and learning modes from a 2004 study conducted by Spring, which observed an extensive number of Australian classrooms where technology was used. First, there was both interactive learning among students and teachers and independent learning in which students and teachers learned on their own in various modes. Second, there was networked learning available in which individuals and groups gained various experiences from each other or from numerous sources. Third, a learning management system enabled teachers to provide individualized learning experiences for students.

Digital learning in Australia has widened learning opportunities for students who are unable to attend a physical school. Digital technologies can benefit those who cannot attend a physical school for various reasons, including rural students, medically homebound students, and students with special needs. First of all, Australia has a long history of distance education that was designed to reach students in rural and outback areas where schools are too far from their home villages. This distance educational system in Australia is called Schools of the Air and there are 15 different schools that have been in operation for more than 50 years (Barbour et al., 2011). In the past, students in these schools received lessons via radio and school materials via post mail. Postmen also delivered students’ assignments to teachers. Since 2003, however, this distance learning system no longer needs to rely on radio and post due to technology development, such as broadband Internet services. Technology affordances for Australian students in distance learning include real-time streaming video, high-resolution graphics, full duplex audio, two-way data interaction and application sharing capabilities.

Another example of widening educational opportunities is Link ‘N’ Learn for those who cannot attend a school for a long period of time due to illness (Wilkie, 2008). This project, which is supported by Australian Research Council and the Royal Children’s Hospital, helped those students continue learning through connection with their teachers and peers. For example, students at home or in hospital can participate in class via videoconferencing, receive one-on-one online tutoring, or watch video recordings of lessons. They can also communicate with their classmates through social network sites, where learning materials can be passed on and questions are asked. Jones and Wilkie (2010) found that despite chronic illness, students were willing to remain included socially and academically by continuing their study. However, there are also impediments and concerns reported by teachers who participated in this project. Things that impeded the management of this online learning project included a lack of school resources, workload pressure for participating teachers, and technical inability of school network to support videoconferencing. Concerning students’ learning processes, challenges included difficulties in assessing students’ work and missing out on collaborative work with peers. The lack of assessments may lead to lack of individualized instruction.

In addition to current state of digital learning in Australian education, research also reported some challenges that are faced by even this technology savvy country. Although state and territory governments have funded online learning courses, high costs of course development is still an issue (Barbour et al., 2011). Several studies suggested that another obstacle is related to professional development for teachers (Ainley, 2011; Barbour et al., 2011; Hayes, 2007). Barbour pointed out that there is lack of funding for teacher training, which may result in qualified teachers who can teach online. Even though ICT-related courses are included in education programs mandated for those who want to be teachers, there are no special training requirements that teachers must have completed in order to teach online (Barbour et al., 2011).
An earlier study of Network Science serves as a cautionary tale that shows the pitfalls of teachers acting solely as passive facilitators (Warschauer, 2011). In the 1980s, the U.S. launched the network science projects that aimed to promote constructivist learning by encouraging students in multiple locations to collect and analyze scientific data, and then share their findings on the Internet. In a 5-year study of network science programs (Feldman, Konold, & Coulter, 1999, Coulter, Feldman, & Konold, 2000), researchers offered a devastating illustration of how these programs ended up failing when teachers served as passive guides on the side, intending to promote a self-directed learning. They found three main trends of students’ technology use: students uploading data to the Internet without downloading others’ data; students not understanding how to analyze or interpret the data they had downloaded in a meaningful way; and students communicating with peers online, but discussing personal and social issues rather than academic ones. The researchers emphasized that the science projects were only successful where there was a very strong in-class, teacher-led component, with teachers explicitly explaining to students the fundamental concepts of how to collect, analyze, interpret, and discuss data. Only then, once the baseline content was shared by a professional teacher, did the Internet-based communication and online resources lead to additional instructional value. In other words, the central feature enabling effective use of Internet-based materials and distance communication turned out to be nimble teacher who both directly guided student learning with appropriate facilitation throughout the learning process and allowed appropriate, scaffolded self-directed learning (Warschauer, 2011).
Teachers who want to transform learning through technology integration need to actively enable and manage deeper learning through ICT. Tomberg et al’s (2013) study of teacher control in a blog-based learning environment suggests that even with collaborative learning based on constructivist approaches, it is still essential for the teacher to retain control over learning activities, such as course enrollment, assignments, and the assessment process, in order to ensure students benefit from self-directed learning. Teachers ought to serve as very thoughtful and critical readers, continually urging students to exert their thinking to a deeper level and integrate their learning to comprehend difficult problems through their knowledge of the basics. In light of this, Bax (2011) argues that teachers need to be “difficultators” and facilitate student thinking to create the need for transformation, or at least reorganization, of perspectives and ideas. Bax also stresses the importance of an effective classroom to be “learning-centered” rather than “learner-centered.”

Given the context, teachers need to embrace multiple roles — as lecturers transferring knowledge to the students, mentors in guiding the students to their designated objectives, and designers in creating classroom curriculums in response to student needs (Warschauer, 2011).

More specifically, literacy teachers are expected to take multiple roles as co-inquirer and researcher during the process of facilitating the socially situated practices of digital literacy (Yayli, 2009). While teacher-student relationship in content-focused curriculum is defined as an expert-novice relationship, in a practice-oriented curriculum that aims to promote digital literacy, the teachers are learners themselves and co-inquirers with their students through “social and symbolic interaction” (Beach & Myers, 2001, p. 25). Although teachers are more knowledgeable in some aspects of their interactions with students, they are also mediators in
appropriate social contexts between knowledge and student through speech or writing, rather than mere transmitters of knowledge. Teachers are also expected to take the researcher role as they create an ongoing practice-research-practice chain in the classroom (Yayli, 2009). This role underscores that teachers need to gather knowledge through systematic inquiry in communities of practice, which then can be used by the teachers themselves, by the immediate teacher community, and finally by the larger community of educators (Cochran-Smith & Lytle, 1993; Yayli, 2009). Teachers can be powerful role models of the value of ongoing learning, how to learn from mistakes, and how to collaborate in mixed ability groups.

In order for teachers to implement technology in the classroom, increase engaged learning, and improve achievement among their students, it is essential that they have a well-planned professional development program for technology use. Such a program empowers teachers to utilize technology as a medium to achieve their overall curricular goals, guiding them through the stages of emergence, application, infusion, and transformation (UNESCO, 2004, 2011). Effective professional development for digital literacy requires careful planning as well as job-embedded and hands-on activities directly linked to the curriculum. It requires plenty of follow-up, built-in evaluations using several assessment techniques, adequate time, sustained funding, and the willingness of educators to take on new and expanded roles.

**Challenges and the need for support.**

Several studies have addressed what helps or hinders teachers’ actual use of technology in the classroom (e.g., Hew & Brush, 2007; Inan & Lowther, 2010). The key barriers that inhibit successful technology integration efforts in school settings include availability and access to computers (Karagiorgi, 2005; Hohlfeld et al., 2008), cost of implementation (Cuban, 2003;
Cuban, Kirkpatrick, & Peck, 2001), teacher beliefs and attitudes toward technology use (Chen, 2008; Lim & Chai, 2008), demographic characteristics of participating teachers (Bebell et al., 2004; Van Braak, 2001), teacher knowledge and skills (Hughes, 2005; Williams et al., 2000), and availability of technical or administrative support for teachers (Sandholtz & Reilly, 2004). Hutchison and Reinking’s (2011) national survey of literacy teachers identified low levels of curricular integration as one of the strongest obstacles to technology integration. Emphasizing the distinction between shallow technological integration that conceptualizes the integration of technology as separate from the curriculum, and curricular integration that views ICTs as integral to the curriculum, the authors conclude that seamless and natural integration of technology is only possible with high levels of curricular integration. This study revealed that a majority of teachers view technology as supplemental, rather than core, to instruction and perceive several obstacles in seamless integration, including lack of time to integrate technology during a class period, lack of access to technology, and lack of technology support and professional development on how to integrate technology.

Some of the solutions to these barriers can be to ensure one-to-one technology access (each student has a dedicated device) and to use tools that minimize the need for technology support or provide sufficient support. For example, our recent study of the district-wide implementation of Google Docs, a cloud-based tool in writing instruction, revealed that due to the simplicity of the tool, both students and teachers were able to be productive with minimal technical support. They did not have to dedicate time or energy to a complicated technology tools, nor was there a frequent need for troubleshooting (Yim, Warschauer, & Zheng, 2014). This is consistent with Sandholtz & Reilly’s (2004) findings that when teachers do not need to
focus on hardware and troubleshooting and districts provide support and training, teachers move quickly to productive and inventive uses of the technology. Technological simplicity helps teachers move beyond *performativity* in technology use, which refers to teachers’ tendency to focus on mastery of complicated hardware or software functions without paying due attention to larger issues of knowledge construction and purposeful learning (Lankshear & Knobel, 2003, as cited in Warschauer, Knobel, & Stone, 2004). Instead of focusing on the completion of technology tasks as ends in themselves, teachers in this district were able to attend to their relevant learning goal, which was to improve student writing.

**Current professional development efforts to promote digital literacies.**

As McPherson et al. (2007) pointed out, there is still much work to do in teacher education to promote digital literacy—helping future teachers understand their own multiple literacies, increasing their awareness of the multiple literacies used regularly and fluently by students, finding classrooms and schools in which future teachers can apprentice in enacting a multiple literacies curriculum, and finally, helping them learn to cope with the forces they will encounter in today’s highly politicized and highly contentious curricular struggles.

Unfortunately, professional development courses on technology integration are limited in content and scope, typically offered as a single technology course (Roby & Dehler, 2010). Several studies have pointed out that teaching technology integration in just a single technology course in the teacher credentialing program is not enough to promote technology use in the classroom (ISTE/NCATE, 2007; Sandholtz, 2001). The National Council for Accreditation of Teacher Education (NCATE) and the International Society for Technology in Education (ISTE) technology standards require effective integration of technology *throughout*
the curricula (ISTE/NCATE, 2007). However, the stand-alone technology courses that are typically offered often end up focusing on basic computer skills (Sandholtz, 2001) and lead to cursory learning of technology skills in isolation (Gunter, 2001).

Most of the current studies on professional development specifically designed to promote digital literacy adopt case study approaches to examine successful cases of training teachers to enhance their digital literacy skills. For example, Miller (2007) explores the role of digital video composing in designing and re-conceptualizing English Language Arts (ELA) teacher education. Comparing three cases of teachers utilizing digital video composing in their classes, this study reveals the challenges (e.g., lack of rigid curricular and equipment) and affordances (e.g., improved student engagement, a new awareness of the social and cultural construction of literacy practices) of integrating a digital tool in literacy instruction and argues that the use of digital video composing in teacher education program will help teachers develop digitally accessible multimodal literacy practices for knowledge-production in schools.

For a case on point, one of the key contributing factors in successful technology integration in South Korea is teacher training (Severin & Capota, 2011). Official ICT teacher training programs exist in each province, allowing teachers to obtain credits for taking ICT classes. In 2006, the Ministry of Education and Human Resources (MOE&HRD) and the Korean Education and Research Information Service (KERIS) revised teacher-training programs to include strategic incorporation of technology in classrooms. Teacher training programs on ICTs include basic use and applications of ICTs, curricular integration, and innovative leadership. This new program has helped teachers use technology more in their classrooms; 72% of all Korean teachers integrate technology in their classrooms (KERIS, 2006). The outcome led to an increase of conducting online teacher trainings via e-learning platforms.

Recent studies on Korea’s L2 digital literacy practices in college settings also suggested a teacher’s critical role in successful integration of technology. For example, Meurant’s (2009) study on Korean EFL learners’ use of multimedia in EFL learning revealed that the degree of technology use in EFL classes is most likely governed by the nature of tasks set by the teacher and by the teacher’s expectations and requirements for students to use digital resources in their classes. Therefore, if the teacher does not specifically encourage or require students to use computers as an alternative to learn English, this is not likely to spontaneously occur.
Other studies have examined virtual opportunities in training teachers to enhance digital literacy skills. For example, Couros (2008) proposed the networked teacher model, which represents an educator’s professional personal learning environment (PLE, or in today’s parlance, usually PLN for professional learning network). He built this model based on feedback from teachers who were actively participating in networked learning for professional development. As can be seen in Figure 3.3, teachers’ professional networks may include colleagues, popular media, print and digital resources, the local community, blogs, wikis, and online communities. It is a model through which teachers begin to build professional connections to support teaching practice. These various sources can be utilized to support teachers in online professional development contexts, providing experience for teacher candidates to develop proficiency with the dynamics and interface of web tools for communication and collaboration (McPherson et al., 2007). Teachers will find a vibrant community engaged in professional learning on social media. Many teachers use Twitter, sharing content, ideas, and collaborating all in 144 words or less under hash tags such as
Implications and recommendations for practice.

Teacher professional development has the potential to provide rich opportunities for the enactment and enhancement of multiple literacies. However, translating the ideas and practices of multiple literacies into a solid teacher development curriculum has met with the challenges discussed above. We offer several recommendations for future professional development efforts to address these challenges and promote digital literacy skills among teachers and their students. As most relevant in the IB context, this section focuses on in-service professional development.

First, professional development efforts need to expand opportunities for teacher collaboration and networking. Instead of working in isolation, teachers can work uniformly, consulting each other to find solutions to problems, acting as peer advisors to provide information and feedback, and collecting data to test hypotheses (Lieberman, 1996, Rodriguez & Knuth, 2000). Professional development for technology use provides opportunities for teachers to become comfortable and effective in these collaborative roles. For example, Lee’s (2007) study on professional development experience of Hong Kong’s secondary school teachers was based on a peer support model. The study revealed that the participants perceived peer support as beneficial in broadening the perspectives of ICT, thus increasing critical reflection on their own technology use, and providing personal and emotional support within a learning community. To encourage peer collaboration among teachers, multiple
venues of teacher networks need to be explored, as displayed in Cuoro’s (2008) model (see Figure 3.3), so that teachers have additional opportunities to discuss the new instructional methods that technology promotes within the learning community.

Second, collaborative cross-disciplinary components are needed in teacher education to infuse digital literacy skills across the curriculum. The integration of technology across disciplines allows teachers of various expertise and content area knowledge to engage in using and critically evaluating technology resources in broader contexts. In addition, given that digital literacy skills of students and teachers are required in all subjects, not just in literacy classes, more attention is needed to encourage teacher collaboration to facilitate the development of cross-disciplinary information literacy skills. One way to achieve this is to encourage teachers of diverse subjects to share their experience and expertise, for example, by co-designing cross-disciplinary projects that incorporate digital literacy practices.

Third, teacher professional development needs to help teachers examine both in and out-of-school digital literacy practices that students are familiarized with and that additionally propels their own learning, as well as the learning of others. Teachers also need to understand their own multiple literacies, increasing their awareness of the multiple literacies used regularly and fluently by today’s students, in order to create and implement learning activities in which students can apprentice in exploring multiple literacies. As today’s students tend to be technology-savvy, teacher development efforts to provide various skills training and technology support are needed to aid teachers in maintaining their pace with their students’ fast-changing use of technology.
However, this skills training must also be in context, content-relevant, and curriculum-related, so that transfer of instruction is more likely to occur. Teacher professional development needs to explicitly connect to student learning and achievement. For example, developing technology integration plans with specific curriculum goals and evaluation methods is practical and more likely to be embraced by time-limited teachers. Successful integration of educational technology is enhanced by focusing on specific instructional goals (Warschauer, 2006) and by developing a shared vision and technology plan to reach those goals (Sandholtz et al., 1997; Lim & Khine, 2006). In order to achieve instructional goals with technology, professional development must address a teacher’s value beliefs with regards to the extent in which technology can be useful in educational integration (Watson, 2006). Therefore, low levels of technological curricular integration often demotivate teachers to use educational technology (Schifer, 2008). In the age of accountability and standards-based reforms, it will be necessary to clearly demonstrate the connection among professional development, technology integration, and learning outcomes. Seamless integration of technology into curriculum will help ensure the enactment of multiple literacies at no cost to performance, a likely increase in engagement, and a clear advantage on measures that privilege a multiple literacies perspective.

In summary, if teachers are to implement technology in the classroom to increase engaged learning and improve achievement among their students, it is essential that they have a well-planned professional development program for the use of technology. Effective professional development for digital literacy requires careful planning as well as job-embedded and hands-on activities directly linked to the curriculum. It also requires plenty of follow-up, built-in evaluations using several assessment techniques, adequate time, sustained funding,
and the willingness of educators to take on new and expanded roles. The success in developing the program empowers teachers to utilize technology as a medium to achieve their overall curricular goal, guiding them through the stages of emergence, application, infusion, and transformation (UNESCO, 2004, 2011).

As a final note, teachers and administrators need to look at implementation of digital literacy within their context. Some schools will have the resources and desire to implement 1:1 digital devices. Others will be working toward implementing wireless Internet access. Wherever a school, teacher, or student may be on the continuum, there are ways to integrate digital literacy. Rushing the process without attention to the details of the context and pedagogical best practices will be counter-productive. Teachers can look for ways to increase digital literacy in their classroom over time, given the resources available. Does one-quarter of the class have smartphones? Group work using the smartphone capability for Internet research or digital polling might be appropriate. Computer lab? Only one computer in the classroom or hallway? There are ways to increase digital literacy with these tools. Digital literacy will look different in every context. The main goal is to continue to explore ways to increase learners’ digital literacy.

**What is the Role of Technology Integration Frameworks in Promoting Digital Literacies?**

From teacher education and practices, to theoretical approaches to what it means to be digitally literate, there are many challenges to promoting digital literacies in the classroom. One approach to tackling this task is to consider the many frameworks that have been proposed as means for structuring digital literacy pedagogies.
There is a virtual alphabet soup of acronyms for frameworks in education, but what role should a framework play with respect to technology integration and promoting digital literacy? Frameworks are only useful if they help us think about a subject matter, idea, or issue better. Frameworks that lack relevance or become rote may ossify teacher practice and remove the fluidity necessary to address the ever-changing context of the classroom. Teachers use frameworks like Bloom’s taxonomy, the dimensions of depth and complexity, or Understanding by Design to help them craft lessons and develop curriculum, as checklists of sorts to make sure they are strategically addressing content, while considering a variety of perspectives and meeting the needs of diverse learners (cf., Veal & MaKinster, 1999, noting the prevalence of the use of Bloom’s taxonomy to evaluate curriculum, Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, et al., 2001). Similarly, technology integration frameworks may provide guidance for educators as they design learning experiences for developing digital literacies of teachers and students. Especially for teachers and programs that are relatively new to incorporating digital literacy into their curriculum, frameworks serve as a helpful reference point. However, frameworks may also bog teachers and administrators down in the details of a particular framework or box them into thinking they must “progress” along the framework without concern for what is best for teaching the particular students the particular curricular goal. Shulman warns of this very risk: “Discovering, explicating, and codifying general teaching principles simplify the otherwise outrageously complex activity of teaching. The great danger occurs, however, when a general teaching principle is distorted into prescription, when maxim becomes mandate” (1987, p. 11). Thus, it is important for the IB to emphasize that the frameworks are a useful took for communicating and thinking about digital literacy, but that
ultimately teachers must consider what will best suit their community of learners in the applicable context to understand the relevant content. Next, we discuss the affordances of the most relevant and noteworthy frameworks, as well as their limitations and assessment measures.

Some frameworks are best suited to guiding teacher education and development—for both preservice and ongoing education. One of the most well known frameworks today for this purpose is TPACK (Voogt, Fisser, Pareja, Roblin, Tondeur, & van Braak, 2013; noting over 600 journal articles about TPACK, Koehler et al., 2014). TPACK helps us think about teacher education and the specialized knowledge of professional teachers. There are other frameworks that use different terms, but in general the frameworks agree that “the advent of new technologies requires teachers to possess knowledge that connects the affordances (and constraints) of these new technologies to the transformation of content and pedagogy” (Koehler, et al., 2014, p. 102; cf., Angeli & Valanides, 2009, p. 155, “All existing views are founded on the common principle that effective technology integration presupposes a conceptualization that must be necessarily formulated by considering the interactions among technology, content, and pedagogy”).

**Figure 3.4** Diagram of TPACK Model
Technological Pedagogical Content Knowledge.

Technological Pedagogical Content Knowledge (referred to as “TPACK” or “TPCK”) is a framework that has gained the attention of both academia and educators. The framework is based on Shulman’s (1986) framework of Pedagogical Content Knowledge (“PCK”), which explains the precise types of professional knowledge possessed by teachers. Shulman’s framework distinguishes between content knowledge and pedagogical knowledge (Shulman, 2006). Content knowledge encompasses both the substantive and the structure of the content area (e.g., how things are known, how they are proven, the relationship between concepts) (Shulman, 2006). Pedagogical knowledge of teaching relates to the subject matter of teaching itself, and pedagogical content knowledge the best ways of teaching a particular content (Shulman, 2006). Curricular knowledge is an understanding of “the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances” (Shulman, 2006, p. 10). The intersection of these domains “is the integration or the synthesis of teachers’ pedagogical knowledge and their subject matter knowledge” (Cochran, King, & DeRuiter, 1999, p. 4) and the specialized knowledge of teachers. There is a significant body of academic research using the PCK framework to analyze teacher education programs (Graham, 2011; Veal & MaKinster, 1999). It should be noted that Shulman’s primary audience for PCK was academia, teacher educators, and policy makers, not teachers themselves (Shulman, 1987). Thus, teachers may not find it a
particularly strong framework to guide their daily activities since it was never intended to fulfill this purpose.

Koehler and Mishra added “T,” for “Technology” to Shulman’s framework, because they believed technology, both digital and analog, was an additional, independent domain (Mishra & Koehler, 2006). As in Shulman’s construct, the remaining domains of TPACK are content and pedagogy; content refers to the subject matter being taught, while pedagogy refers to the process and practice of teaching (Koehler, Mishra, & Yahya, 2007). Early formulations of Shulman’s categories of teachers’ knowledge base also included “knowledge of learners and their characteristics, knowledge of educational context, and knowledge of educational ends,” (Shulman, 1987), which are subsumed in TPACK’s general “context” layer. TPACK is “grounded and situated in specific contexts” (Koehler, et al., 2014, p. 102). Thus, TPACK encompasses the main domains of technology, content, and pedagogy, as well as the 4 interrelationships, TCK, TPK, CPK, and TPACK (the intersection of all 3 main domains) (Koehler, Mishra, Kereluik, Shin, & Graham, 2014).

Koehler, Mishra, & Yahya make it clear that TPACK is intended to address the fact that teacher preparation and faculty development “requires appreciation of the complex set of interrelationships between artifacts, users, tools, and practices” and that technology itself should be treated more broadly as a “knowledge system” (2007, p. 742). The connections and interactions between the main domains are emphasized in TPACK (Koehler, Mishra, & Yahya, 2007). Thus, technological content knowledge (TCK) “refers to knowledge of the reciprocal relationship between technology and content. Disciplinary knowledge is often defined and constrained by technologies ant their representational and functional capabilities” (Koehler, et. 
One useful feature of TPACK is that "it calls attention to the ways that technology is too frequently separated from content and pedagogy and makes explicit the need for the integration of all three in instruction" (Warschauer, 2011, p. 77). Further, Technological Pedagogical Content Knowledge “refers to knowledge about the complex relations among technology, pedagogy, and content that enable teachers to develop appropriate and context-specific teaching strategies” (Koehler, et al., 2014, p. 102). In a teacher development program intentionally integrating technology education into the content areas of teacher preparation, TPACK was a useful framework for instructors and teacher candidates to use when trying to communicate around the effort of integration (Foulger, Buss, Wetzel & Lindsey, 2014).

Nonetheless, like its predecessor, the strength of the TPACK framework is in teacher preparation and development, not analysis or preparation of daily classroom curriculum.

Both PCK and TPACK have created challenges for researchers, because they attempt to describe complex realities and the distinctions between the various categories are not always clear (Graham, 2011; cf., Cavanagh & Koehler, 2013). This lack of clarity leads to difficulties in creating teacher development strategies (Niess, 2011) and in crafting valid assessments to understand the degree to which preservice and in-service teachers have “attained” TPACK or are progressing in their development of TPACK. Attempts at assessment have taken the form of self-report measures, open-ended questionnaires, performance assessment, interviews, and observations, but most of the instruments were used without evidence of reliability or validity (Koehler, et al., 2014). Future efforts to create assessment instruments need to have a clearer focus on validity issues in their measurement (Cavanagh & Koehler, 2013).
However, some efforts at constructing and validating assessment measures have created useful instruments such as an instrument designed to measure preservice teachers’ self-assessment of their TPACK and related knowledge domains (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Shinas, Yilmaz-Orden, Mouza, Karchmer-Klein, & Glutting, 2013). The instrument was specifically focused on early childhood and elementary contexts, assessing the content areas of literacy, mathematics, science, and social science only. The survey results were quantitatively reviewed for the validity and reliability of the instrument, with each subscale’s Cronbach Alpha assessed for internal consistency (ranging from .75-.92), and construct validity assessed with principal components factor analysis (Schmidt, et al., 2009; cf., Abbitt, 2001, noting this survey as among the more mature assessment tools available). The instrument was promising, although limited to a specific context (cf., Abbitt, 2011, suggesting that the need to apply instruments to a specific context for validity also reduces the broader use of each instrument). Validity and reliability analyses were also limited due to the small pilot sample size.

In another strong TPACK instrument, researchers developed and validated a TPACK survey to assess secondary mathematics preservice teachers. Surveys were done at 15 institutions and completed by more than 300 teachers. The results of the survey suggest that the instrument accurately captured the three main areas, technology, content, and pedagogical knowledge, but not the interrelated domains (Zelkowski, Gleason, Cox, & Bismarck, 2013). It is worth noting that the correlation between the four factors revealed that TK and PK have a low correlation, suggesting that they are, in fact, different constructs, while TPACK is correlated moderately with each of the three main constructs. The final 22-item survey was found to be
valid, reliable, and manageable. Because the survey is intended to measure self-efficacy, and self-efficacy influences whether or not teachers can or will implement technology, the authors believe the self-report measure is useful.

Some studies, such as the Zelkowski, et al., study discussed above, have suggested that the difficulty of assessment is not simply a measurement problem, or a lack of rigor in the research, but a result of the relatively large number of intersecting constructs and the novice status of preservice teachers, which makes it difficult for the teachers themselves to discern the layers of each construct. Zelkowski, et al. hypothesize that the intersections may be more difficult for preservice teachers to grasp because the constructs are complex and the teachers are still learning the more general constructs (2013). This is an issue that preservice programs struggle with, in technology and in other areas, “Given the recent inclusion of technology in education, many preservice teachers have had limited experiences in learning their subject matter with technology” (Niess, 2005, p. 520). Although preservice programs are evolving to address this issue, the extent of technology integration will vary by program and by country. In addition, if self-assessment surveys are used and the teacher is unable to discern between pedagogical content knowledge and content knowledge, he or she is likely to be a poor self-evaluator. It also may not simply be the novice teachers having difficulty discerning the differences, but actual overlap of the domains since subscales of TPACK have been highly correlated and raise the question of whether they are, indeed, separate components (Koehler, et al., 2014; see Shinas, et al., 2013, noting that teachers appear to have trouble conceptualizing TCK, for example, as a distinct knowledge domain; cf., Lee & Tsai, surveying 558
Taiwanese teachers’ self-efficacy and Web TPACK and noting difficulty to distinguish between WPK and WPCK).

TPACK has limitations as a construct. Some researchers argue that technology is not needed as a separate construct, but was already encompassed in Shulman’s PCK because curricular content knowledge includes instructional materials and tools useful for teaching a certain content. “The fundamental question, then, is whether these types of digital tools are sufficiently different from other, more traditional tools, to require their own category of knowledge” (Brantley-Dias & Ertmer, 2013, p. 106). Koehler and Mishra suggest that they are different enough because unlike other tools, technology is not as specific, stable, or transparent, but how is this different from curriculum changes, like the Common Core State Standards? The emphasis of the framework on technology may also intimidate novice users of digital technology: “Regrettably, by framing this new knowledge primarily in terms of technology (i.e., by putting the “T” first in the acronym, the focus on content and pedagogy, as originally proposed by Shulman (1986) became somewhat lost” (Brantley-Dias & Ertmer, 2013, p. 107).

The evolution of TPACK in academic literature may be summarized as one of three tracks, TPACK as extended PCK, TPACK as a unique and distinct body of knowledge, and TPACK as the interplay between three domains of knowledge and their intersections and in a specific context (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). “Shulman’s notion of PCK included the appropriate use of technologies when teachers need to think about representations of the concept that is being taught to students” (Voogt et al., 2013). Mishra & Koehler argue that technology knowledge needs to be a separate, third knowledge domain
(2006). Others are concerned that the concepts embedded in TPACK, particularly the intersections, are too vague to assess and too complicated for teachers’ to use well and discriminate between. Others make both arguments, “Like PCK, TPACK is easy to understand at a surface conceptual level. One intuitively recognizes the importance of integrating knowledge domains related to pedagogy, subject matter, and technology. However, the simplicity of the model hides a deep underlying level of complexity, in part because all of the constructs being integrated are broad and ill-defined” (Graham, 2011, p. 1955). Whether these concerns are merely academic, as some might dismiss them, or practical, it is important to maintain some perspective on the integration of technology into the curriculum and to realize that developing teachers will have varying strengths and weaknesses that must be both accommodated and either utilized or remedied.

On the other hand, some complain that important factors are left out of the TPACK framework: “One of the real disadvantages to using TPACK to frame our conversations about technology integration is that, in general, it tends to ignore a host of other variables that have been shown to significantly affect the technology integration process” (Brantley-Dias & Ertmer, 2013, p. 115) such as teacher beliefs (see Bate, 2010, for a discussion of the importance of pedagogical beliefs in technology adoption as shown in a 3 year Australian study of beginning teachers), teachers’ self-efficacy, goals, school vision, classroom culture, etc. An additional concern is that TPACK seems to deemphasize the learner differences that PCK recognized. Although context is a part of the underlying concept of TPACK, it tends to get less focus than the three categories of knowledge and the intersections of these domains. And finally, “having” TPACK and using it effectively are two different things, “even if teachers have TPACK, they may
not be able or willing to use this knowledge to affect meaningful student outcomes” (Brantley-Dias & Ertmer, 2013, p. 115).

Similar frameworks include ICT-Related Pedagogical Content Knowledge, Knowledge of Educational Technology, Technological Content Knowledge, Electronic Pedagogical Content Knowledge, and Technological Pedagogical Content Knowledge-Web. Like TPACK, ICT-Related PCK is based on Shulman’s model, but it differs in that technology is integrated in teaching within PCK rather than being a separate body of knowledge (Koehler, et al., 2014, p. 103). ICT-Related PCK is focused on information and communication technologies and specifically includes “knowledge of students and knowledge of the context within which learning takes place,” although Shulman’s model and TPACK already acknowledge those pieces (Angeli & Valanides, 2009, p. 158; Angeli & Valanides, 2005). Knowledge of Education Technology (Margerum-Lays & Marx, 2003) similarly treats the teaching with technology as an integrated part of Shulman’s model, rather than a separate body of knowledge interacting with the other domains (Koehler, et al., 2014, p. 103; Abbitt, 2011). Technological Content Knowledge (Sough & Connell, 2006) is a bit more different, in that it emphasizes a total intersection between technology and content, rather than as separate but overlapping areas. Electronic Pedagogical Knowledge (Franklin, 2004) is less a framework and more a specific type of teacher knowledge that exists alongside the other domains of content, pedagogy, and curriculum and “emphasizes pedagogical practices specific to educational technology rather than conceptualizing technology as a distinct realm of knowledge” (Koehler, et al., 2014, p. 103). Finally, Technological Pedagogical Content Knowledge-Web replaces general technology with the World Wide Web (Lee & Tsai, 2010). As the summary above illustrates, these models are somewhat different
(e.g., integrative versus transformative models, see Graham, 2011), but are all based on the idea that teachers must learn to connect technologies to content and pedagogy.

**Frameworks for teaching and curriculum.**

Frameworks for curriculum and teaching are focused on helping teachers think about, and have a framework for their thinking about, how to use specific tools in connection with the curriculum and daily classroom activities. These frameworks include RAT and SAMR. RAT has served as a framework underpinning more academic research, but SAMR is widely popular in the teacher development and educational technology community. SAMR was articulated by Ruben Puentadura (also a co-author of TPACK) and consists of a continuum of substitution, amplification, modification, and replacement (Puentadura, Transformation, Technology, and Education, 2006, online at http://hippasus.com/resources/tte, downloaded 9/28/14; see also Puentadura, As We May Teach: Educational Technology from Theory to Practice, 2009, online at http://tinyurl.com/aswemayteach, downloaded 9/28/14). In substitution, technology acts as a direct tool substitute with no functional change and augmentation is a step up because it has functional improvement--both are considered enhancement categories (http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf, downloaded 9/28/14). The higher-order transformation category consists of modification, where technology allows for significant task redesign and redefinition, where technology allows for the creation of new tasks that were previously “inconceivable” (http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf, downloaded 9/28/14). The SAMR framework has been criticized as not specific enough to guide educators in improving their use of technology
Quality academic research on SAMR was not found. To the extent SAMR is a useful construct to aide in communication and consideration of curriculum development, the lack of research is not fatal. However, SAMR should be used with the understanding that the hierarchical judgments made about what are higher and lower order uses do not have a grounding in research on learning, pedagogy, or memory and are thus somewhat arbitrary.

**Figure 3.5**

*Diagram of SAMR Framework*

RAT stands for replacement, amplification, and transformation (Hughes, Thomas, & Scharber, 2006). The goal of RAT was to increase critical decision-making about integrating technology into the curriculum (Hughes et al., 2006). Hughes et al. specifically noted that they viewed technology as a means to a pedagogical end, not an end of itself (2006). They believed that teachers need evaluative frameworks to help guide their own technology implementation and strategies to assess their use of technology in the classroom in a systematic manner (Hughes et al., 2006). Teachers need to look at their own instructional methods, the student learning process, and the curriculum goals to guide the analysis of their technology use. In evaluating usage under this framework, replacement means to simply replace but not change
established practices and learning processes. The technology serves merely as a different means to the same instructional end. Amplification enables increased efficiency and productivity and is focused on improved effectiveness or streamlining rather than change. Finally, transformation is not nearly as well defined, but requires that “the instruction, the learning process, and/or the content is fundamentally different, and the technology played a central role in developing such a transformation” (Hughes et al., 2006, np).

Not quite in either the teacher education genre or the curriculum development genre, the International Society for Technology in Education has developed standards for both teachers and students relating to the use of technology in school (www.iste.org). The ISTE standards are quite broad, and may have less value for planning of teacher development or curriculum and be more helpful, like the ACOT framework discussed below, when administrators are planning integration efforts or evaluating classroom use of technology. The standards for teachers consist of the following: 1) facilitate and inspire student learning and creativity, which echoes the TPACK framework—“Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments”; 2) Design and develop digital age learning experiences and assessments; 3) Model digital age work and learning; 4) Promote and model digital citizenship and responsibility; and 5) Engage in professional growth and leadership (http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf, downloaded Sept. 23, 2014). The student standards are similar. The ISTE standards have been used in research (see, e.g., Barron, Kemker, Harmes, & Kalaydijian, 2003, for a large
school district survey focused on the prior ISTE standards, or NETS) and are well known in educational technology professional development circles.

The Apple Classrooms of Tomorrow (ACOT) Adoption Framework is a slightly different type of framework than those discussed above. The work of Sandholtz, Ringstaff, and Dwyer (1997) provides a model of the five stages of technology adoption by teachers. The five stages of technology adoption by teachers consist of entry, adoption, adaptation, appropriation, and invention (Sandholtz, Ringstaff, & Dwyer, 1997; Mills & Tincher, 2003). This framework is useful particularly for administrators implementing technology programs and evaluating new teachers and their developmental progress along the adoption continuum. There is significant research using the ACOT framework as a basis for evaluation of technology integration programs.

Other frameworks focus on observation protocols for determining the quality of classroom teaching and incorporate some consideration of the teacher’s use of technology in the classroom. The Gates Foundation looked at some of the leading observation protocols in connection with its Measures of Effective Teaching (MET) project (Gates, 2012). Many state and local agencies have adapted or created their own frameworks regarding educational use of technology (cf., Allsopp, Hohlfeld, & Kemker, 2007). For example, the Florida Center for Technology Integration has the Technology Integration Matrix (http://fcit.usf.edu/matrix/matrix.php). This matrix includes specified levels of technology integration into the curriculum: entry, adoption, adaptation, infusion, and transformation [based on ACOT] and active, constructive, goal directed (i.e., reflective), authentic, and collaborative (Jonassen, Howland, Moore, & Marra, 2003). It is similar to the Technology Integration Standards Configuration Matrix (TISCM) developed by Mills and Tincher (2003), as a
set of standards, organized into phases to reflect a developmental approach (cf., Gorder, 2008). Thus, the Florida matrix attempts to combine technology adoption with a more general, constructivist teaching framework for curriculum and classroom evaluation. There is minimal academic research using this framework, but the site has a questionnaire and observation tool available for assessment use.

An international framework by UNESCO (2004, 2011) proposed an ICT pedagogic framework (see Table 3.3) that is similar to the TISCM. The UNESCO framework describes the required key aspects in a teacher’s competency and pedagogy for the effective use of ICT (Asia Education Foundation, 2013). The illustrations that sit along a continuum are intended to display what is effective in accordance to various starting points with respect to ICT integration. It is worth noticing that teachers who take on the role as a facilitator to balance the inconsistency as the stage of technology integration advances to infusing or transforming stage and moving beyond the emerging or applying stage. In emerging or applying stages, teachers mostly use technology as a supporting tool for instruction and tend to focus on the mastery of technology skills, whereas in infusing or transforming stages, teachers concentrate on the seamless integration of ICT into curriculum and teaching, fostering deep and transformative learning.
<table>
<thead>
<tr>
<th>Technology Integration Stage</th>
<th>Emerging</th>
<th>Applying</th>
<th>Infusing</th>
<th>Transforming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher roles</td>
<td>Teachers learning about ICT</td>
<td>Teaching with ICT</td>
<td>Facilitating student learning with and/or through ICT</td>
<td>Enabling and managing deeper learning through ICT</td>
</tr>
<tr>
<td>Descriptions</td>
<td>- Teachers experience good pedagogy as a student. Daily life in the classroom, teaching and management is enhanced through ICT use. Teachers require an understanding of the ICT productivity tools available (e.g. information searching, Web 2.0 tools, and online teaching and learning resources)</td>
<td>- Teachers integrate ICT in lesson planning and use multimedia tools in their teaching. - Using ICT-based generic pedagogical skills, they present/guide/search for information, create content, and facilitate learning. - Teachers are able to use authoring and multimedia tools based on quality pedagogy in their teaching.</td>
<td>- Teachers design ICT-enabled lesson plans and digital materials, creating pedagogically proper learning environments. - Using ICT-based subject-specific pedagogical skills, they conceptualize learning, organize ideas, and facilitate online collaboration. - Teachers are able to use, for instance, Web 2.0, subject-specific learning tools, Mind Mapping, WebQuest etc. to facilitate student learning.</td>
<td>- Teachers enable and utilize a pure blended learning environment, which involves the seamless integration of ICT-based and face-to-face teaching. - Teachers possess autonomous professional learning skills focusing on quality pedagogy using ICT (both subject specific and generic). - Teachers use, for example, synchronous (e.g. web conferencing) and asynchronous (e.g. LMS) tools, as well as interactive activities (e.g. games) to value-add to what students might otherwise already learn via more conventional means.</td>
</tr>
</tbody>
</table>


We have only touched on the most widespread frameworks. Other frameworks include ICT-Related PCK, Knowledge of Educational Technology, Technological Content Knowledge, Electronic Pedagogical Content Knowledge, and Technological Pedagogical Content Knowledge-Web. Fields such as computer science, information and computer science, informatics, and business have created frameworks relating to the use of digital technology for teaching and learning. Nonetheless, these frameworks generally fall into one of the categories above and have the same basic goals and structure. These frameworks may be particularly helpful to new teachers as they are learning to construct curriculum and plan out their classroom teaching activities.
Frameworks and implications for IB.

Finally, we will discuss the implications of these multiple frameworks for the IB as it strives to promote digital literacy in IB schools. The ability to communicate in a variety of modes in more than one language is essential to the IB concept of an international education that promotes intercultural perspectives. This should extend to the ability to communicate using both analog and digital technology. As education professionals, teachers should be aware of, and conversant in the major frameworks discussed above, “One of the important roles of theory development in a community of inquiry is to provide a common language and focus for productive discussion and knowledge creation” (Graham, 2011). All educators should be able to participate in the discussion around the use of technology in education. Thus, ongoing teacher development should include some basic introduction to the key frameworks. Professional development needs to be content-driven to the extent possible, incorporating digital technology when and where it makes sense for the learning goals and context (Warschauer, 2011; cf., Mills & Tincher, 2003). However, in the end the goal of good teaching supersedes any particular digital technology framework. Teachers and administrators should consider whether technology is incorporated into the curriculum in thoughtful ways that promote authentic, relevant learning and communication by a diverse student population.

While the frameworks, particularly those focused on curriculum rather than teacher development, may help teachers develop practices around technology, they also create a risk that digital technology will be over-emphasized. The frameworks’ focus on digital technology risks overlooking classic teaching methods, which remain effective in many instances. In addition, the frameworks tend to stress “transformation” and subjugate “replication” in their
hierarchical nature – but in some instances replication is quite powerful. Word processing tools may simply be replication, but they provide scaffolding for learners with poor handwriting skills or for English language learners through spell check features, for example, or text-to-voice. They provide authenticity to student writing, since most writing in higher education and the workforce is done using computers. A simple check off box in an assessment or survey of teacher technology use might not sufficiently value the use of word processing tools if viewed as replication, not transformation.

Ultimately, educators and education communities within the IB family should use frameworks to discuss and plan curriculum and teaching to the extent productive for furthering their goals. The right framework will depend on the context and the goals, "Because there is a high degree of variability in educational beliefs, technological availability, and state and community expectations, technology integration should be locally defined, using available research models and national standards as a foundation" (Mills & Tincher, 2003, p. 384). Ultimately the goal is for students to develop the intellectual, personal, emotional and social skills to live, learn and work in a rapidly globalizing—and often digital--world. IB learners are strong communicators and should be able to effectively utilize analog and digital communication tools. The IB community of educators should use frameworks as tools to help get the learners to this goal.
CHAPTER 4: CONCLUSIONS

This report explores digital literacy from multiple facets in an attempt to crystallize strategies and suggestions for integrating these practices into curricula. Using examples from around the globe, we discussed conceptualizations and theories underpinning digital literacy education, highlighted pedagogical strategies for teaching according to these conceptualizations, emphasized the need for teacher education, and identified the strengths and weaknesses of current technology education frameworks. Across these components, we found that guidelines and frameworks that avoid the techno-centric and instead focus on learners and their communities are best suited to teaching the critical inquiry, collaboration, and communication skills necessary for 21st Century learners. Consideration of these ideas will be critical as IB educators work to develop curricula for this generation of students.

A review of the measurement of TPACK, both surveys and performance, with analysis of major instruments.


The author identifies important factors that need to be included in math in science teachers in Australia in terms of ICT use.


Formative study for the development of TIM. TIM was based on two models that support the integration of technology for facilitating student centered instruction based on social constructivist theory: Jonassen's Constructivist Learning Environments and the ACOT Levels of Technology Integration.


This report provides the definition, historical development, and assessment standards of information literacy for higher education.


Discussion of Bloom's taxonomy, revised for curriculum preparation and assessment.

This article focuses on theoretical, epistemological, and methodological issues relating to TPCK, specifically in connection with ICT (information and communication technologies). The authors blame the failure to adequately prepare teachers to teach with technology on educational technology courses’ emphasis on the acquisition of technical skills, without sufficiently exploring the content and content-specific pedagogy that should be incorporated. They note, the “thing that has become clear is that the mere introduction of technology in schools will not have the desirable outcomes, that is, technology in and of itself is not a transformative mechanism or a vehicle for change. Rather, it is a tool invoked by its users to reconstruct the subject matter from the knowledge of the teacher into the content of instruction” (p. 157). Angeli & Valides contend that TPACK is, indeed, a distinct body of knowledge, and that growth in any one individual domain (T, P, or C) does not necessarily mean growth in TPACK. The authors finally discuss technology mapping (TM) as a situative methodology for developing ICT-TPCK.


Updated information from Apple’s ongoing studies of the use of computers in classrooms.


This report provides the results of the International Survey 2011, which replicated and extended the 2006 International Survey conducted by the North American Council for Online Learning. The survey included 23 questions that focused on government involvement, numbers and characteristics of students taking online course, professional development of instructors, quality standards of online courses, challenges for online learning, and technology used by students. A total of 50 countries responded to this survey and shared the state of their online learning policy and practice for primary and secondary students. The results give us insights on strategies and challenges of online and blended learning in practice.


This article sheds light on the communicative practices that have emerged as a result of new technologies and how these practices relate to literacies. Baron discusses the extent to which computer-mediated communication represents a different literacy and how the modality or form of communication can transform communication and knowledge.

Barrett proposes that portfolios—particularly digital portfolios—offer affordances with regards to student engagement, learning, and assessment. She suggests that e-portfolios firstly can serve as an assessment of student learning by providing an opportunity for students to collect “artifacts” of their work that can be assessed based on a rubric; this summative assessment can provide extrinsic motivation. She also proposes that portfolios can also serve as a formative assessment by encouraging intrinsically motivated learning. This type of portfolio can provide students with a place to assemble works of their own choosing (not dictated by teachers) that educators provide feedback on and review *with* the student.


Survey of over 2,000 K-12 teachers on instructional modes and technology integration.


A longitudinal study examining the use of information and communication technologies by new teachers in their first three years of service. Teacher pedagogical beliefs did not necessarily translate into practice with regards to using technology to engage students.


This chapter raises the question about the nature of digital education and perceives the behavior of students and the role of educators in virtual spaces. Five elements of effective educational practice are identified: (1) access to knowledge, (2) participation and interaction, (3) expert intervention through scaffolding of activities that check on students’ progress, (4) expert modeling, and (5) challenges and contradictions from an expert and from other learners.

This article introduces digital tools that students can employ to construct knowledge collaboratively in response to texts. These tools include social bookmarking or digital note-taking tools as well as annotation tools.


A framework for middle and high school English instruction wherein students are engaged via inquiry-based projects and exercises.


A survey study of teachers’ self-reported technology use suggests that multiple measures reflect different constructs with regards to teachers’ use of technology in the classroom.


This study explored the effectiveness of a one-to-one computer initiative in the NE United States that took place across several middle schools. The study took pre- and post-measurements of student achievement, engagement, and research skills and found significant boosts to each of these. Teachers generally had to bear the burden of this initiative, with practices and materials of more successful teachers undergoing large changes over the course of the program. In general, feedback from teachers and students suggested that the program was beneficial for developing digital literacy skills in addition to boosting academic achievement in other content areas.


Belshaw proposes that digital literacy is composed of eight practices: cultural, cognitive, constructive, communicative, confident, creative, critical, and civic. He suggests that conflating digital practices with traditional literacy practices might prevent full understanding, through research and practice, and proposes a simpler conceptualization.

Study of the two modalities in elementary school children found general benefit to the use of pen over keyboards.


Black examines fan fiction sites and how they empower users—and in her study, English language learner adolescents—to participate in collective knowledge construction. This work uses Gee’s *affinity spaces* framework to examine the motivations for young people to participate in such communities, to develop digital and print literacies, and to engage in identity development practices.


The authors examine the use of Google Docs and its effects on sense of text ownership, collaborative cloud-based writing software that enables users to work simultaneously on documents. They assigned groups to share their work with either peers or an audience that was not known to them and found that while groups varied in their perceived ownership and perceived quality of work, groups did not vary in their perceived learning of the material. Students in the study also expressed that they felt collaboration produced a higher quality final product. Collaborative work via tools such as Google Docs may provide students with more opportunities to generate knowledge as a team and to boost efficacy.


Bloch describes his experiences teaching second language learners using blogs as a way to promote discussion and writing on a sensitive topic—plagiarism. This paper focuses on a Somali “Generation 1.5” immigrant and how his academic writing changes and improves as he learns writing strategies via blogging. He analyzes how giving and receiving peer feedback, the low-stakes platform, and the semi-casual space contribute to this particular student’s writing development.


This book examines through classroom case studies how technologies can be integrated into instruction for second language students.

This thoughtful article examines the development of TPACK and notes that despite numerous articles since Mishra and Koehler’s presentation of the framework, little progress has been made towards producing either a simple, precise definition of the TPACK framework and its seven knowledge constructs or developing a sound way to measure it. “TPACK takes the concept of technology integration and packages it as a framework that is much too big (i.e., one that embodies seven distinct knowledge types) while simultaneously making it too small by dividing the “package” into so many pieces that they have become impossible to distinguish from one another” (p. 104). The article proposes to re-focus on the aspects of technology integration knowledge and skills that are most productive to achieve learner-centered pedagogical use. The article proposes this definition of TPACK, “teachers’ knowledge of how to integrate content knowledge with appropriate pedagogical approaches, including those that use emerging technologies, to enable learners to master the subject matter at hand” (p. 106). The authors propose moving TPACK to a circle within PCK, rather than as its own content area, reducing the number of interrelated subareas.


In this Master’s thesis, Breitkopf analyzes the use of the one-to-one laptop initiative, One Laptop per Child, as a way to promote technical skills and information access among students in rural Peru. Breitkopf finds that the initiative largely ignored cultural and community needs of these students and provided little in the way of the technical infrastructure, such as electricity and wireless (or any) Internet connectivity, for these schools. Moreover, teacher turnover, lack of teacher training, and lack of parental buy-in or training was a significant barrier to the use of laptops in schools.


This chapter discusses the needs of new literacy assessment practices to support new multiliterate learning environments. Some of the suggestions for new assessment are: assessment (1) is a process that engages the learner’s thinking and multimodal performance, (2) uses open methods instead of a numerical mark, (3) provides a more comprehensive account of achievement drawing on formal/technical and the process/collaborative aspects, and (4) is flexible to fit individual and collaborative shaping. Challenges for such assessment practice to be implemented are: (1) while multiliteracy learning often has interdisciplinary nature, current learning practice focus
on individual disciplines, and (2) while classroom-based assessment practices may accommodate multimodal learning, state-wide assessment may not.


As a teacher-researcher, Bruce examines high school students’ use of video production and editing as part of an English language arts program. He found that the process of producing a video involved much revision, peer teaching, and multimodality (the use of multiple modes of representation such as audio, video, and text). Students were also highly motivated to complete their projects, and most collaborated on their final work. He concludes that video projects might be one way to both motivate students and to encourage the types of revision and iteration that translate across both digital and print text production.


This paper addresses the issue of digital competence and assessment by suggesting a conceptual model for what constitutes digital competence. The authors suggest three dimensions—technological, cognitive, and ethical, based on which they designed and tested a set of assessment tools called Digital Competence Assessment.

Castek, J. (2012). If you want students to evaluate online resources and other new media—teach them how. In D. Lapp & B. Moss(Eds.), Exemplary instruction in the middle grades (pp. 105–123). New York: Guilford.

Castek argues that explicit instruction is necessary for teaching students how to seek and evaluate information sources online. Explicit instruction strategies are discussed. Castek describes how restricting “web exploration” hinders rather than helps students as they develop strategies for finding and evaluating online resources. Online activities can enable authentic, critical inquiry, but these must be accompanied by instruction, such as discussing and practicing strategies for evaluating website content and credibility. Additionally, these activities might be done in the context of other content areas; online information seeking should be taught as a vital part of research across subjects.


This book describes how the “Information Age” has transformed a post-industrial world. He suggests that the world—including education, society, politics, and sociocultural relations—are adapting to an information economy. One theme that emerges from this
work is the need for digital literacies as young people face a global, information technology-driven economy.


This study examined the use of laptops in 11 school districts in the US state of Florida. The use of laptops in the classroom was found to especially improve pedagogical practices, such as increasing student-centered instruction. Although student achievement was found to increase, there remained some challenges with introducing the technologies, such as technology infrastructure and teacher professional development issues.


The New London Group provides a theoretical overview of the connection between the social environment and a new literacy pedagogy they call “multiliteracies.”


Discussion of the use of iPads in higher education.


This study describes the initial development process of iPad pedagogy by analyzing the pre-implementation teaching practices shared at a national professional development event. This study specifically examines to what extent the shared practices display technological pedagogical content knowledge (TPCK) during the pre-implementation stage. The analysis demonstrates that the initial level of integration of iPad into the curriculum was limited and may require additional time and practice in order to move from an emphasis on tools to an emphasis on content.

This article discusses the dearth of validated measures of TPACK, the rationale for TPACK’s 7 criteria, and the currently available measures of TPACK. The article provides a suggested framework for good measurement validation.


This article discusses the role of preservice education in advancing multiple literacies, arguing that teacher education can transform school practice to support multiple literacies. It offers accounts of multiple literacies practices in and out of school and calls for three changes in preservice education to better support multiple literacies: preservice programs should (a) engage teachers in analyzing technology and media, (b) help teachers develop an understanding of literacy, and (c) help teachers understand their own and their students’ multiple literacies.


An overview of the Cyber Home Learning System, an initiative by the South Korean government with the goal of reducing educational inequality via in-home online supplementary activities.


This paper addresses how the concept of cooperative learning can be incorporated into an e-learning context. As a cooperative learning approach, peer assessment in a group plays an important part in both teaching and the learning processes, which allow student to assess the others’ contributions in a group. The authors developed a Fuzzy Peer Assessment System in which all students participate in all phases of the assessment processes. Students cooperatively create the peer assessment questionnaire and assess other peers’ works and the system finally assigns the appropriate score to each student.


Using qualitative methods, the author studied 12 Taiwanese high school teachers and found that there was a disconnect between teacher beliefs and practices with regards to technology in the classroom.


Discussion of several types of technology use in classes looking at the motivational impact of each. Ultimately, technology is found to be not inherently motivational, but that the motivational impact depends on the context.


This report examines the current status of educational technology use in Hong Kong at both national and school levels. It mainly discusses the discrepancies among schools in terms of degree and sophistication of IT in education practices. Based on the government survey conducted in 2009, this report also provides information on students’ computer access rates and their perspectives on using technology in instruction.


Paper on considerations for preparing teacher candidates to apply pedagogical content knowledge. Encourages modeling by the faculty when teaching.


Explores the use of new technologies as catalysts for creative pedagogy, rather than technocentric uses.


A framework for approaching teacher research from a university/academic perspective as well as from the voices of teachers.


Coiro provides activity sheets, learning objectives, and a set of challenges for instructors to use for teaching evaluation of online resources. For example, one learning objective is to cross-check facts and claims using the example of the Pacific Northwest Tree Octopus
site, a bogus joke site about a mythical animal that from appearances might look like a factual site.


This paper explored how shared online reading affected a way that a pair of students collaboratively constructed knowledge based on what they read and discussed online texts. Two 7th-grade female students participated in this study, sharing reading processes and addressing inquiry questions. It was found that two students used different strategies while reading independently. For example, one student focused more on acquiring specific information, while the other student focused more on summarizing information. However, engaged in shared reading, two students modeled strategies for each other.

Coiro, J., & Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. Reading research quarterly, 42(2), 214-257.

The authors examine how middle school students read information and find information on the Internet and find that prior knowledge, reasoning skills and strategies, and self-regulation of reading contributed to student outcomes.


An overview of makerspaces and hackerspaces. The author proposes that libraries may be repurposed for collaborative, community making.


This book discusses pedagogical approaches to digital/multiple literacies and highlights the necessity of shaping education to meet the needs of a changing global landscape. They suggest that these multiple literacies, including digital literacies, must not be seen as threatening the authority of educators but as a way to expand a teacher’s “repertoire.”

An evaluation of a one-to-one laptop program in the United States. The study suggests that increased access to technology in a one-to-one environment poses many challenges for teachers, such as the need to develop new curricula with a mind toward technology integration.


This report summarized findings from an examination of the Alabama, US deployment of One Laptop Per Child laptops; it found that although students sometimes had improved access to technology, in general laptops did not improve student academic outcomes.


This paper presented findings from a study of One Laptop Per Child laptop deployment in Birmingham, Alabama. The researchers found that teacher training and their use of the laptops in the classroom was a key factor in student outcomes, suggesting that use of technology in the classroom necessitates professional development and teacher buy-in.


A guide for teachers using online activities in the classroom that encourages educators to critically evaluate the necessity and function of Internet activities.


The author developed a model of the networked teacher that represents an educator’s professional personal learning environment (PLE) based on feedback from teachers who participated in networked learning for professional development. Teachers’ professional network includes colleagues, popular media, print and digital resources, the local community, blogs, wikis, and online communities. It is a model through which teachers begin to build professional connections to support teaching practice. This model may serve as an example of the teacher professional training program in distance learning contexts.

A case study of a teacher using project-based inquiry and integrated technology use as a means for enabling student research skills.


This report examined the effects of the One Laptop Per Child Program in Peru. The authors find that the effort was unsuccessful due to lack of professional development for teachers, lack of technological infrastructure, and a dearth of educational resources.


A critique of standards-based school reform.


An argument against policies and initiatives that ignore the role of teachers and instructional practices.


Cuban argues that because 1:1 was not prevalent in university classrooms, 1:1 computing in K12 schools is folly; he suggests that laptops merely enhance existing teaching and learning practices.


This article explores the relation between access to technology and student learning in two high schools in a technology-supportive school district. Based on qualitative findings, the authors conclude that high access to equipment and software seldom led to widespread teacher and student use. One of the key findings is that classroom use of technology sustained, rather than altered existing patterns of teaching practice.

This entry argues that bilingual students’ first language can serve as a powerful intellectual resource, and bilingual instructional strategies can usefully complement monolingual strategies to promote supplemental cognitively engaged learning.


This text explores several case studies and on-the-ground examples of pedagogical strategies for teaching literacy and technology skills in schools. These examples emphasize the need for community-focused, cross-cultural education, such as the Project FRESA example wherein a teacher engaged migrant farmworkers’ children in an action research project.


This study compares three cases, each with a different teacher role (executor-only, redesigner, co-designer) in curriculum design and how the different level of teacher involvement influences curriculum implementation and student learning outcomes. In the executor-only role, teachers implemented ready-made activities whereas in the redesigner role teachers collaboratively re-designed existing activities, and in the co-designer role, teachers collaboratively designed new activities. Significant learning gains were found for each teacher role, but the extent of integration of technology-rich activities was highest in the co-designer case and lowest in the executor-only case. The results suggest the importance of empowering teachers in curriculum design for successful integration of educational technology.


This review of over 70 studies focuses on students most at risk of dropping out of school. Extensive discussion of limited resources available to these students and emphasizes need for 1-1 technology for them. Strong recommendations regarding improved teacher support.

Poor use of TPACK to analyze curriculum and unclear use of ACOT 5 stages to determine levels of TPACK.


A call for further research on how media technologies can create an immersive environment for learning.


The authors discuss some of the history and politics of digital literacy as well as how digital literacies differ from traditional or print literacy. The authors suggest that digital literacy differs significantly from print literacy. For example, social media enables individuals to exchange text, visuals, and sound. Together, digital media users can construct knowledge; directionality and authority in learning is changed. Additionally, the authors discuss how digital literacy does not equate print illiteracy.


A critique of the online tool, WebQuest, and a discussion of how to make the platform more engaging for users.


The authors provide a comprehensive perspective on the processes of effective learning and the environments in which learning best takes place, drawing on findings from the fields of neuroscience, cognitive and social psychology, human development, and technologies. The findings highlight a number of strategies to facilitate effective learning, such as learner-, knowledge-, and community-centered instruction. In addition, the authors advocated the use of ongoing assessments, which enable teachers to evaluate students’ preconceptions and progress toward learning when designing instructional plans.


A review of the Common Core State Standards, the recently developed standards for U.S. public schools, with suggestions for digital literacy education strategies for teachers.

Discussion of the findings from the ACOT study focusing on teacher beliefs and the link to practices.


This review surveys provide data on Hong Kong schools’ implementation of Information Technology in Education (ITEd) in an attempt to review the progress of the ITEd initiatives. The findings are presented in six areas: IT facilities and accessibility, resources, IT deployment in schools, IT deployment for learning and teaching, students’ awareness/competency in use of IT, and parental support. Based on the survey results, recommendations are also provided for each of the six area.


The author argues that assessments of digital literacy should include skills such as locating information, the ability to work and research independently, critical evaluation, and problem solving in addition to knowledge of specific technologies.


A report on the Maine Learning Technology Initiative, a program whereby seventh- and eighth-grade students and teachers in Maine each received a laptop for academic use. The study found that teachers reported using more student-centered approaches and interdisciplinary work. They also reported more cooperative and collaborative work among students and teachers.


This study found that for peer assessments, multiple corroborating ratings were not any more accurate than a single peer assessment.

Randomized control study providing laptops to 6-10th grade students in California. The study found no academic improvements. No other interventions were provided, suggesting the benefit or more well-rounded interventions to improve learning outcomes.


This book analyzes the long-term educational implications of the network science projects launched in the 1980s. This project aimed to promote constructivist learning by encouraging students to draw from scientific databases, to analyze and interpret data, and to communicate and discuss their conclusions. The authors stress the importance of a teacher’s active role in promoting meaningful collaboration and learning from the networked learning environment, as well as teachers’ science knowledge and nontechnology skills in making network science accessible for students.


This study reported the findings from a survey of 168 teachers on their use of blogs in their classroom. Eighty-nine percent of teachers responded that the use of blogs for their classrooms changed the instructional methods, such as collaborative work and interaction among students.


The authors investigate the effectiveness of an online wiki for high school science education. Although wikis are designed to be open collaborative tools, the authors were surprised to find that the technical challenges of using the wiki made collaboration frustrating and often meant that students produced text alone.


Discussion of Arizona State University’s efforts to integrate technology into the content classes for teacher candidates and use of TPACK as a framework.

Quantitative study of 121 recent education graduates. 6 support factors for elementary teachers’ use of computers were identified in a factor analysis—leadership; access and availability; incentives; personnel support; external constraints; and philosophy and preparation.


Gee describes affinity spaces, a framework for learning in out-of-school, non-traditional contexts. He argues that digital literacy is the ability to seek out these affinity spaces and to develop a sense of ownership over one’s learning—something that is too often missing from classroom experiences.


This work provides an overview of different “new literacies” as a practice/field as well as a summary of the history of these fields. Gee suggests that digital media and learning is a moving target that is still coalescing into a discipline—and thus the notion of digital literacy is still developing. He describes how researchers from many fields are attempting to develop theoretical and pedagogical frameworks. He suggests that because digital media use and practices are highly diverse, this interdisciplinary approach is necessary for establishing just what we mean when we talk about digital/new literacies.


This paper presents a web-based educational setting that supports both individualized and collaborative learning and assessment. This setting, called Supporting Collaboration and Adaptation in a Learning Environment, enables learners to work on individual and collaborative activities and to participate actively in the assessment process in the context of self-, peer- or collaborative- assessment activities.

A meta-analysis of a decade of work on the effect of computer use on student writing. The study found that computer use was associated with large positive effects on quantity and quality of student writing.


Discussion of a multinational workshop on online teaching and the necessary skills needed by instructors in the online environment.


This paper from a professor and information systems perspective references a much different literature base. Nonetheless, similar themes emerge – a need to move from teaching the technology to teaching the knowledge integration and analytical skills technology can support.


Strong critique on the validity and construct integrity of many TPACK measurement instruments.


A qualitative study examining how technology could be used to promote communication between parents and teachers and to bridge students’ out-of-school interests with in-school learning. The study found that students were hesitant to share their out-of-school interests and expertise, which they deemed might be embarrassing. Educators must work to create a safe “third” space between in- and out-of-school knowledge where students can choose to selectively share their knowledge.


This book has 7 major findings: 1) proper implementation of technology is linked to education success; 2) properly implemented technology saves money; 3) 1-to-1 schools that employ the Project RED Key Implementation Facts outperform all schools, including all other 1-to-1 schools (top four implementation factors are intervention classes that use technology every class; principal leads change management training at least
monthly; online collaboration among students daily; core curriculum using technology at least weekly); 4) the principal's ability to lead is critical to the success of an implementation effort; 5) technology-transformed intervention improves learning; 6) online collaboration increases learning productivity and student engagement; 7) daily use of technology delivers the best return on investment.


Examination of laptop 1-1 programs in three diverse California schools.


This study evaluates an introduction to technology course for pre-service teachers and its effectiveness as a potent resource in teaching strategies. Data analysis reveals that student teachers had less anxiety after completion of the web-enhanced course and an enhancement in their teaching strategies, such as adjusting teaching style to student’s level of technology use.


This case study examines second language students’ development of digital literacies as they engage with an English for Science course project in Hong Kong. The project involves student use of a course weblog along with video production and sharing software. Groups of students worked collaboratively to plan, film, and share short science documentaries through video and Web 2.0. The findings reveal that the experience helped the student writers raise awareness of readers and develop appropriate discourse identity.


The authors describe digital literacy in terms of what it means to be a “digital participant.” They suggest that participation is an alternative way to consider digital literacy because it is not necessarily positive or negative and necessitates not only skills but also knowledge, resources, and understanding. They propose that digital literacy can be defined as the ability to “read” and “write” with new digital media, the ability to obtain knowledge via these new media, and the ability to understand how these media and technologies affect how we obtain knowledge, e.g., media literacy. They also explore five dimensions of digital literacy, including operational (ability to read/write), cultural (understanding texts within cultural contexts), critical (recognition of social
construction of knowledge and digital media practices), creative (content creation), and collaborative (ability to work with others via digital means).


Study examining use of iPads in higher education, includes limited discussion of SAMR.


Whereas the “digital divide” initially framed technological inequality in terms of physical access to digital devices and the Internet, Hargittai suggests that an emerging digital divide is one defined by differences in skills and uses of technology.


This article presents survey measures of web-oriented digital literacy. The authors aim to strengthen the validity of observations and survey questions based on which digital literacy skills are typically measured. To combat validation issues, the authors provide a set of recommendations for developing new types of survey proxy measures that can better assess people’s observed web-use skills.


Challenging the idea that all young people are “digital natives” who can inherently use digital media, Hargittai conducts a study of Internet skills among young people and finds large within-group variation. These differences suggest that different experiences and access to resources might contribute to different Internet skills and knowledge; when teaching young people, it cannot be assumed that they will all have the same technology skills and practices.


Surveying young people, the authors find that higher levels of education are correlated with increased “capital enhancing” activities online and more savvy use of online resources. They find that online skill mediates this relationship. These findings stress the importance of digital literacy as a means for academic as well as social development as well as the need for more equitable digital literacy education.

This qualitative research paper examined ways in which teachers in six public schools (primary, high) in Australia were utilizing ICT to mediate students' learning experiences. The author used classroom observations and interviews with teachers, principals, and technology coordinators about the integration of ICT. Each participating school selected teachers who were considered to be innovative and confident users of ICT in that school. Five to eight classrooms were visited in each school. Most teachers indicated that ICT integration had supplemented existing instruction, rather than it had fundamentally changed the way of teaching.


This article outlines several strategies for teaching online information literacy and describes the SEARCH framework for online research: *Setting* a purpose for searching, *Employ* effective search strategies, *Analyze* search-engine results, *Read* critically and synthesize information, *Cite* sources, and evaluate *How* successful the search was.


This study examines the use of Google Apps for Education as a means for promoting collaboration and communication among students in a university setting. Although the focus of this study was emerging adults rather than K12 students, the article suggests that adoption of this suite of software tools can enable the distributed, collaborative work among students. The article has specific technical recommendations for implementing these tools.


This study identifies the general barriers typically faced by K-12 schools when integrating technology into the curriculum for instructional purposes. The barriers that this study examines include lack of resources and lack of institutional support. The authors also identify several current knowledge gaps regarding the barriers and strategies of technology integration.

Development and implementation of a teacher survey on use of technology in classrooms.


This study presents a theoretical model to examine the digital divide within schools and examines a four-year statewide data from various schools to investigate significant trends in ICT integration by school level and SES in Florida. Results expose significant differences between high and low SES schools in terms of student access to software, teacher use of software, and the extent of technology support.


This study examines the score comparisons between writing tests taken through paper and computer that was administered to eight-grade US students. The results show that computer familiarity is a strong predictor, suggesting that depending on students’ level of computer familiarity, the two modes of assessment are likely to produce different results.


This multi-case study explores the nature of teachers’ learning during technology professional development activities that aim to increase technological pedagogy. It also examines the extent to which their technology-enhanced pedagogy improves as a result of professional development opportunity. The results suggest that grounding teachers’ learning experiences in content-based, technological examples was the most effective way of developing their own technology-supported pedagogy.


Discusses TPACK as part of teacher knowledge and RAT as part of curriculum development analysis. Looks at 13 teachers in a MA educational technology class.

Introduces the RAT rubric for assessing the use of technology in the curriculum. Designed to look at the connection between the technology and the actual learning objective and pedagogical means.


Hull and Schultz examine out-of-classroom digital media practices. They suggest that too often digital literacy practices in the classroom are disconnected from out-of-classroom sociocultural contexts and communities. They propose that one way to improve digital literacies pedagogies is to encourage the cultural literacies and expertise that students bring with them from their communities and homes.


This study examines literacy teachers’ perceptions of integrating technology into literacy instruction based on a national survey of U.S. literacy teachers. The authors use descriptive statistics, an exploratory factor analysis, and a path analysis to test a model hypothesizing a relation between teachers’ perceived importance of technology and reported levels of integration. Results show relatively low levels of curricular integration, consistent perceptions about obstacles to integration, and technological rather than curricular definitions of ICTs and of integration. The findings reveal the extent to which technology is being integrated into literacy instruction and what factors should be considered toward increasing integration consistent with expanding definitions of literacy.


This study examines the direct and indirect effects of teachers’ individual characteristics and perceptions of environmental factors that influence their level and extent of technology integration in instruction.

This document defines information and communication technologies as a component of the IB Primary Years Program. The document asserts that ICT is by necessity a component of a transdisciplinary program in that it enables students to develop collaborative, investigative, and creative skills. Pedagogical strategies include an increased emphasis of collaborative, cross-curriculum, embedded ICT use and a de-emphasis isolated ICT instruction.


This document reviews the profile of an IB learner, the learner in relation to his or her IB World School, and how teaching and learning develop in an IB education. The document reviews a framework based on inquiry, action, and reflection, whereby students become engaged critical thinkers. Additionally, this document emphasizes the importance of global, multilingual education as part of the IB framework and goals.


The authors use ethnographic method to describe how young people (students from primary school to college) use digital media. They find that young people participate in “always on” communication as they are constantly connected with each other via devices and media. They describe three patterns of participation, including “hanging out” (casual participation), “messing around” (more exploratory and participatory behavior), and “geeking out” (knowledge construction and collaboration; developing expertise) online. They also identify barriers to participation in digital media, including economic, social, institutional, and cultural factors. They explore the extent that peer-based learning can be facilitated by these new media.


This paper reports on two studies conducted in 2006 in the Singapore schools to investigate the relationships between teachers’ beliefs about knowledge and learning, their pedagogical practices, and uses of information and communications technologies (ICT). In Study 1, 1882 teachers from 51 schools took part in the 187-item online survey on these areas, and Study 2 involved eight principals, two vice-principals, 33 heads of department, and 60 teachers in structured interviews. It had been hypothesized that beliefs about the nature of knowledge being complex and changing would be associated with more learner-centered pedagogical practices and uses of technology in the classrooms. However, the main findings of Study 1 suggest that it is not epistemological beliefs of teachers about knowledge and knowing that shape pedagogical practices in
Singapore schools, but rather teachers’ beliefs about learning. From the interviews in Study 2, it appears that teachers tend to mix pedagogical strategies consisting of both teacher-directed and learner-centered approaches primarily based on beliefs about learning. Our research findings also suggest that epistemic ideas teachers may not be relatively fixed and stable “beliefs” but rather are more contextually influenced epistemic resources.


This work provides cases of youth “participatory cultures,” e.g., collaborative creative communities that have low barriers to access and provide mentorship and social connections. Jenkins discusses digital literacies as participation consisting of 11 key skills: play, performance, simulation, appropriation or remixing, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, and negotiation. He discusses examples of these skills and means for promoting them among young people.


This study examines the effectiveness of using digital textbooks on student learning in South Korea. The results suggested an increase in problem solving skills, self-directed learning skills, and achievement results including English, math, and science. The authors discuss the opportunities and challenges of implementing educational reform with innovative digital textbooks, and suggest some models of implementation.


A response to Mueller and Oppenheimer’s (2014) study comparing note-taking via computer and paper, Jones suggests that there is a strong need for digital literacy education that explicitly instructs students in the positive use of technologies for learning. For example, students must receive clear instruction with regards to taking notes via laptop; they cannot be assumed to know how best to take notes via every medium. Similarly, he argues, students cannot be assumed to have the experience and skills to use any technology; apprenticeship and modeling are required.

This paper analyzes difficulties of math teachers who were responsible for contacting students who participated in instruction online due to their chronic illness.


This study conducted an analysis of the availability and effects of media literacy education among students. The study found that media literacy education was not strongly correlated with student demographic background, but that access to this type of literacy instruction was associated with increased political engagement.


This study examines the implementation of ICT technologies in Cypriot elementary schools. Based on the differential patterns of technology integration in the four schools examined, the authors stress the need for a different implementation policy according to the contexts and users.


ETS’s iSkills assessment is a large-scale, Internet-delivered assessment that measures students’ abilities of using technology to handle information. This assessment emphasizes the cognitive problem-solving and critical-thinking skills associated with using technology. In this assessment, components of ICT literacy include (1) defining an information problem, (2) accessing information in digit environment, (3) evaluating the relative usefulness of information, (4) managing/organizing information, (5) integrating, (6) creating a data display, (7) communicating with a particular group of audience. Students respond to 15 interactive performance-based tasks, which are not in multiple-choice format, for 75 minutes. Responses are automatically scored.


This descriptive case study examines the affordances of implementing mathematical computer games as a medium for teaching mathematics. Findings suggest that students perceive the use of game-based math learning as beneficial, particularly in creating dynamic learning opportunities through, for example, tutor-tutee reactions. The improvement in learning outcomes was not statistically significant, however.

The authors evaluate how collaborative work and peer assessment function within a college environment. They suggest that collaborative assignments should be paired with ongoing peer assessment for more learner-oriented, timely feedback.


This report reviews the historical development of South Korean education policies related to educational technology. One of the main achievements this report highlights is the revision of teacher training programs to include strategic incorporation of technology in classrooms.


This article discusses the potential of e-mail in promoting language learning and cultural awareness through international communication. The author stresses the key role of teachers in organizing coherent and meaningful e-mail projects and promoting student motivation.


This book chapter discusses three central themes in networked language learning: linguistic interaction and development, intercultural awareness and learning, and development of new multi literacies and their relations to identity.


The authors note that the TPACK framework emphasizes the connections among content, pedagogy, and technology to produce effective teaching. In particular, the intersection of all three “refers to knowledge about the complex relations among technology, pedagogy, and content that enable teachers to develop appropriate and context-specific teaching strategies” (p. 102). This theory and development of the framework are described, along with approaches to measure and develop teachers using TPACK. Assessment or measurement instruments are generally self-report measures, but some open-ended questionnaires, performance assessment, interviews and observations have been used by researchers. Most of these measures have no evidence of reliability or validity.

Quantitative discourse analysis of an online course development class using TPACK as framework for the analysis.


This article aims to review experiences and then draw lessons of these four major Asian cities/regions in the development of e-Learning policies on the dimensions of infrastructure, curriculum integration, students learning, teacher professional development, as well as leadership and capacity building. It is identified that each of the four major Asian cities/regions has its own area of emphasis in the planning of future e-Learning policies, with Singapore focusing on scaling up good practices of e-Learning among teacher community.


This study examines the functions of StarCraft in supporting knowledge creation and learning of online game players, and also in meeting their learning needs. The findings reveal that the learning gained from expert players are different from novice players in that they assemble in small groups and learn through communicating within private media channels, rather than generally learning from public media channels. In relation to this pattern, the authors discuss the distinctive natures of informational media and socially-oriented media.


This study depicts the story of Almon, a young person who developed both digital and traditional literacy skills as he constructed his online identity. In order to create a website and to communicate with an online community of peers, he developed website development and writing skills. The drive to define oneself might be a key motivator with regards to learning digital literacies.

Lankshear and Knobel describe a framework in which digital/new literacies are not merely skills (“technical stuff”) but also a means for collaborating and doing distributed work (“ethos stuff”). The authors suggest that there are two mindsets, one in which new literacies have simply changed the medium for old practices, and one in which new literacies represent a transformation of literacy into new, participatory, and fundamentally different practices. In order to address digital literacy education, we must consider both “technical stuff” and “ethos stuff.”


The authors discuss how there are a “plethora” of digital literacies and that they represent a collection of social practices; they suggest that being digitally literate is a “condition, not a threshold.” They outline the four components of digital literacy, which they describe as underpinnings (the technical skills and access necessary to participate in digital practices), background knowledge, central competencies (ability to understand digital content and formats), and attitudes and perspectives (the independence and social knowledge and practices to be able to engage in and learn digital practices).


This book discusses the concept of legitimate peripheral participation (LPP), which correlates learning with participation, and how LPP leads to a new meaning of portable knowledge.


This chapter reports the 21st century pedagogical orientation of math and science teachers, drawing on the data from the SITES 2006 study. The findings provide implications to pedagogical changes with regard to the 21st-century requirements and the use of ICT in classrooms.


Literature review of methods to understand and evaluate teacher uptake of technology and the impact on teaching and learning of professional development on technology integration.

A framework for understanding TPACK-W or web. Study of over 500 teachers in Taiwan. Teacher beliefs and self-efficacy were factors in successful integration of technology and pedagogy.


This study investigates the potential of peer support to enhance professional development of ICT integration for secondary school teachers in Hong Kong. According to the findings, the participants perceived peer support as beneficial in broadening the perspectives of ICT, thus increasing critical reflection on their own technology use and providing personal and emotional support within a learning community.


In this study, Lei and Zhao evaluate the effectiveness of a one-to-one laptop program and find that in addition to academic benefits, the relationships among students, their families, and schools were also improved.


The authors find that teenagers engage in many diverse forms of writing, from composing emails to communicating via text messages. They also find disparities across populations; low-income students tend to have less access to technologies such as computers and the Internet.


The authors discuss the use of online assessments in order to gauge student skill with navigating the Internet, conducting research, and evaluating sources.

This article illustrates that the new literacies of online research and comprehension is a process of problem-based inquiry through the use of information on the Internet. New literacies include the skills, strategies, dispositions, and social practices that are present as people read online information to learn and are based around five practices. These practices include (1) reading to identify important questions, (2) reading to locate information, (3) reading to evaluate information critically, (4) reading to synthesize information, and (5) reading to communicate information.


The authors explore the literacy practices of youth who use instant messaging. They examine how these young people engage in literacies in this new medium and find that they frequently multitask among multiple conversations and narratives, using text to convey specific content and tone. Additionally, they discuss the use of instant messaging as a means for identity development.


This conceptual paper suggests the potential of networked media in developing flexible activities and responsive structures, replacing compliance with a culture of inquiry, and helping to reinvent leadership.


This article examines how four Singaporean schools overcame barriers to ICT integration. The authors identify six strategies for effective implementation, which include collaboration among teachers in preparing ICT-mediated lessons and support provided by school leaders in addressing teachers’ ICT concerns.


This meta-analysis synthesizes findings from (quasi-) experimental studies conducted between 2000-2012 to examine the association between the use of computer-mediated communication (CMC) and second language acquisition. The results showed a positive
and medium effect from CMC interventions, but were interpreted as tentative due to the small n-size of some variables under comparison.


Study involving middle school foreign language, one semester, using a retrieval practice software to improve course retention.


An overview of the activities of the Los Angeles Makerspace, including their efforts to include educational opportunities for youth.


This article provides an overview of the concept of multimodal literacies and reviews innovative pedagogical approaches to multimodal literacies involving second language learners.


Education is becoming more personalized and at the same time more socially connected than before. Web 2.0 and 3.0 provide instructors and learners with the opportunity for a closer contact with digital tools that can facilitate such individualized and socially connected learning. The authors suggest that it is imperative to integrate three skills into curriculum to promote digital learning in which Web 2.0/3.0 tools are used: e-skills, e-literacy competences, and soft skills. The authors find three types of e-Skills that go beyond simple ICT skills (e.g., sending emails): practitioner skills (e.g., developing or managing ICT systems), user skills (e.g., using ICT systems and devices), and e-business skills (e.g., enhancing efficiency of an organizational performance in business areas). E-literacy, also known as digital literacy, refers to competences that an individual need to acquire knowledge through digital processes. Soft skills are defined as personal attributes that are needed for interpersonal interactions, such as communication skills, critical thinking, analytical skills, and creativity.

The authors argue that globalization and rapid technological development have consequences for learning and teaching. They suggest that policy and practice struggle to adapt to the changing forms of identity development and digital practices of youth and propose that old mindsets and preferences for print literacies may undermine new teaching practices that address digital literacies.


Study of the use of digital text in high school social studies classroom found academic benefits across a diverse student population.


This chapter discusses the changes ICT technologies brought to writing instructions and writing processes. Particularly, the review stresses the effects of computer-mediated communication as it affects writing, including intercultural communication projects and the use of networked communication in writing classes.


Pre-dating the explication of the TPACK model by Mishra & Koehler, this article analyzes teachers’ development of educational technology usage using Shulman’s PCK framework. The authors provide a qualitative case study of 6 participants (3 preservice/teacher mentor pairs) based on interviews and observations. The researchers documented the flow of knowledge between student teachers and their mentors as well as each participant’s growth in technological knowledge. “Of the three components of knowledge explored in this study, [PCK] was the most difficult to define and to separate out for analysis” (p. 455).


This article provides a practical overview of several types of instruction that support development of new literacy skills among teachers. They introduce web-based tools for communication and collaboration, such as blogs, wikis, virtual literature circles, and digital concept mapping and argue that including these tools in teacher preparation programs will prepare pre-and in-service teachers with skills to create meaningful and productive learning contexts.

National study of library use examined by socioeconomic and racial status.


This study outlines principles of learning that facilitates the development of 21st century skills. This included models of excellence and on-going feedback, which stresses that learners need to be shown models of excellent work and be provided with regular, timely, and user-friendly feedback in order to practice, retry, rethink, and revise their work.


This study reports the second language digital literacy practices at a university in South Korea, calling for the need to implement comprehensive computer-mediated instruction in the second language classroom and to divert administrative resources to teaching needs.


This case study explores the role of digital video composing in designing and reconceptualizing English Language Arts (ELA) teacher education. It argues that the use of digital video composing in teacher education program will help teachers develop digitally accessible multimodal literacy practices for knowledge-production in schools. Comparing three cases of teachers utilizing digital video composing in their classes, this study reveals the challenges (e.g., lack of rigid curricular and equipment) and affordances (e.g., improved student engagement, a new awareness of the social and cultural construction of literacy practices) of integrating a digital tool in literacy instruction.


Discussion of technological fluency. The authors created a set of standards, organized into phases to reflect developmental approach. They also created interventions and professional development modules based on Concerns-based adoption model, and a survey.

One of the first explications of TPACK. Describes origin in Shulman’s PCK and the need for an additional domain for technology. Emphasis on the interrelations between and among domains. Like the dichotomy between content and pedagogy that Shulman was addressing, "knowledge of technology is often considered to be separate from knowledge of pedagogy and content" (p. 1024) and "the relationships between content (the actual subject matter that is to be learned and taught), pedagogy (the process and practice or methods of teaching and learning), and technology (both commonplace, like chalkboards, and advanced, such as digital computers) are complex and nuanced" (p. 1025). "Technologies often come with their own imperatives that constrain the content that has to be covered and the nature of possible representations. These decisions have a ripple effect by defining, or in other ways, constraining, instructional moves and other pedagogical decisions" (p. 1025).


Moilanen provides an overview of the hackerspace/makerspace movement and its emphasis on collaborative work, peer teaching and “peer-production.”


Meta-analysis based on 27 studies with weaker writers, 20 of which were not considered in prior reviews. From 77 independent effects, the following average effects were greater than zero: writing quality (d = 0.52), length (d = 0.48), development/organization of text (d = 0.66), mechanical correctness (d = 0.61), motivation to write (d = 1.42), and preferring word processing over writing by hand (d = 0.64). Especially powerful writing quality effects were associated with word processing programs that provided text quality feedback or prompted planning, drafting, or revising (d = 1.46), although this observation was based on a limited number of studies (n = 3).


The authors conduct an experiment in which they compare students’ note-taking skills via computer and via pencil and paper. They find that students using a computer for notes tended to take verbatim notes, whereas students better synthesized information via their traditional pen and paper note-taking.

This report is a survey of 120 major American corporations that examines the importance of writing in today’s workplace. The findings indicate that writing is a gatekeeper to professional opportunity and that companies spend billions of dollars annually to correct written deficiencies of their employees.


This is the official website for the Common Core State Standards, a new set of academic standards for K-12 students that includes content knowledge as well as skills. These standards encompass topics such as math, writing, and science. These standards also define 21st Century skills as vital to public education.


The authors compare the introduction of computers and technology resources to libraries in middle- and low-income areas. They found that pedagogical and community practices around these new resources differed. They also found that the introduction of similar technologies widened the “gap” in technology and literacy practices between these libraries. The article suggests that care must be taken when introducing new technologies; community practices and teaching strategies contribute to how children use technologies.


This qualitative study examines how and why people share health information online in both online health communities and Facebook. The results indicate that several goals (e.g., emotional support, accountability, advice) affect the patterns of information sharing and success in meeting these goals depend on how well people develop their social networks and their online communication skills.


This is a speech about Singapore’s educational history delivered by Singapore’s Minister for Education at the International Education Summit. Singaporeans are migrant population—Malay, Chinese, and Tamil—and had a disparate education system, which might lead to high dropout rates and poor literacy outcomes. Factors that have improved the national educational achievement involve centralization, decentralization, and technology integration. In the first phase of development, the nation provided top-down resources so that ground-up innovations can flourish, such as a very strong centralization of curriculum, teacher training, teacher recruitment and examinations. In the next phase, Singapore allowed schools more autonomy that can help develop different areas of strength in order to nurture each child in terms of creativity, 21st Century competencies, higher literacy and numeracy skills. Currently, Singapore has ICT-infused pedagogy and curriculum. This pedagogy is aligned with decentralization in that it involves platforms that made it easier for school leaders and teachers to decide how best to integrate ICT into teaching and learning.


The author suggests that while young people have grown up in a digital age, technological skills such as the ability to use specific software or online learning management systems still require explicit instruction.


Preservice PCK evaluated in science and math program over 1 year with 22 student teachers.


A reflection on PCK and TPACK over the development of the concepts and review of empirical results.


This column discusses the potholes and possibilities of integrating digital literacies in classrooms, setting a broader background for the challenges teachers may face in using technology in their instruction. The authors identify several challenges in integrating
educational technology: (a) the gap between the out-of-school digital literacies practices and official standards and assessments and (b) the institutionalized structures of schools being incompatible with the purposes and enactments of digital literacies. Although this article does not specifically deal with teacher preparation program, it implies how teacher preparation program can be used to overcome the challenges in integrating digital literacies in school settings.


This report evaluated the level of technology access and instructional use in US schools and provided policy implications and recommendations for teacher professional developments. It stresses that teachers need to gain insight into the potential of technologies, opportunities to apply them, and time to experiment.


This report provides a range of broadband-related statistics gathered by the OECD. The information includes a range of indicators which reflect the status of individual broadband markets in the OECD.


A study of one district’s development and implementation of a standards-based curriculum.


An article on the program’s official wiki describing the five principles of the One Laptop Per Child initiative: 1) *child ownership* of the special XO laptops in order to enable ownership and empowerment; 2) *low ages*, e.g., 6-12 years old, so that the students engage in play; 3) *saturation*, e.g., every child in a locale has an XO laptop; 4) *connection* to the Internet via a wireless network, and 5) *free and open source* software to enable access to learning tools.


The author compared pedagogical practices of three Nordic countries, Denmark, Finland
and Norway, in order to identify differences between Finland and two other countries. All the three countries have launched policy and investment to promote digital literacy, but Finnish students had a remarkable accomplishment in International Student Assessment (PISA). Analyzing data from the IEA SITES 2006 study, which three countries participated in, the author found that the difference lied in ways in which teachers used ICT rather than the amount of the ICT use. The Finnish science teachers were more likely to use ICT in lifelong learning practices than those in the other two countries. They were also more autonomous in their pedagogical choices in making use of ICT in practice than the Danish and Norwegian teachers.


This book discusses how computers can change school from a classic thinker about computers and education.


This chapter discusses word decoding, language comprehension, and text interpretation as being central to second language (L2) reading. Examples of using digital media, such as visual-syntactic text formatting and collaborative blogging, are also introduced as ways to enhance each component of L2 reading.


The authors describe the utility of portfolio assessments for engaging and challenging students. They suggest a portfolio assessment will 1) enable students to learn about learning; 2) be assembled by the student and thus be more valuable to him; 3) not merely be cumulative but involve selection and curation; 4) involve rationales for including each piece, and 5) change over the term, perhaps accumulating or losing pieces as it is assembled.


This article explores the need for digital literacy among teachers and the challenges that are faced in preparing educators for teaching in the 21st century. Based on an analysis of three effective professional development models for promoting digital literacy, it identifies the features crucial to the successful implementation and integration of technology in the K-12 classroom. They include administrative support, time for
teachers to learn new skills and integrate technology in their curriculum, and the development of a community of teachers working with technology.


This study explored the effects of an Internet-delivered universally designed depth of vocabulary intervention. Both English-speaking and Spanish–English-speaking students (N = 240) participated in the 16-week intervention. The intervention contained eight multimedia texts that targeted 40 words and embedded reading strategy support. Students were able to access all texts and activities in Spanish and English. There were significant effects on measures of vocabulary knowledge and depth, but effects were non-significant for comprehension.


This paper explores an automated feedback system for writing assessment. This case study reports user experience and provides implications for the next phase of development.


This survey study presents the sets of educational technology skills that are preferred by teachers, technologists, and administrators.


Understanding the role of teachers is critical in the development of technology use in schools, the authors discuss important factors to be included in professional development.

This paper explores a collaborative learning process in which two participants at a distance worked together and provides implications for system design.


This book explores the concept of the Universal Design for Learning that helps ensure that all students, who bring different educational needs to learning sites, achieve the same standard of learning.


This paper comprehensively reviews the literature on research, pedagogy, and practice with regard to new literacies.


This study examined the use of individual laptops in elementary schools. The authors contrasted the use of shared laptop carts, whereby classrooms share laptops and distribute them during class, versus one-to-one programs whereby students each receive individual laptops. The study found that one-to-one laptops were used more often across curriculum. Additionally, one-to-one laptops were more often used at home for educational activities.


This paper discusses one of instructional methods that blended learning approach in which technology and face-to-face learning are combined to assist students in learning. That is flipped learning. The paper describes the history of this relevantly new instructional approach, flipped learning, its mechanisms, and pros and cons. Successful examples and guidelines on how to implement are also discussed.


This case study examines a school where the curriculum is based on the principles of game design, such as cross-curriculum “quests” and collaborative project-based
learning. The article stresses that in this school, it is not only the digital tools that have changed but also the pedagogy, which stresses problem solving and collaboration.


The authors, teachers at a high school in the U.S. began using new software that allowed them to synchronize voice over power point slides in 2007. For example, they recorded and posted their live lectures online for students who were missing class. Since they were asked to speak around to other educators about this teaching method, online videos and podcasts were being used across the county. This was the beginning of flipped classroom in the K-12 education. The authors described successful instructional practices in several content areas in this paper.


Comparison of teacher development programs utilizing the ACOT framework of technology integration and adoption.


This paper reports how teachers in one school district successfully integrated technology in their classrooms by emphasizing curriculum over technology.


Drawing on the data from the Apple Classrooms of Tomorrow studies, the authors identify several aspects of technology-incorporated classrooms, such as changed roles of teachers and students, how to manage technology rich classrooms, and supports from administrators.


This study illustrates a successful computer-related professional development program, called the Continuous Practice Improvement program that was implemented into the Kindergarten through eighth grade classrooms of a Philadelphia school.

This article discusses the development and testing of a survey instrument (the Survey of Preservice Teachers’ Knowledge of Teaching and Technology) designed to assess the seven domains of TPACK reported by PK-6th grade preservice teachers. The pilot instrument was tested on 124 teachers. The instrument is specifically focused on early childhood and elementary contexts, assessing content areas of literacy, mathematics, science, and social science only. The survey results were quantitatively reviewed for the validity and reliability of the instrument, with each subscale’s Cronbach Alpha assessed for internal consistency (ranging from .75-.92), and construct validity assessed with principal components factor analysis. The instrument was promising, although limited to a specific context, and has been one of the most frequently used survey in subsequent research.


Thorough discussion of assessment theory and practice in the age of digital technology.


Selwyn discusses the history of the “digital native” concept, which is the idea that children who have been raised since the introduction of computers and the internet inherently have skills and learn in a fundamentally different way than previous generations. He warns that the idea of the digital native disregards the “messy” inequalities in technology access and use, the instances of resistance to technology, and the necessity of social and academic resources with regards to technology skills development.


This report analyzes how the integration of technology in education contributed to the national economic growth in South Korea. It highlights that in South Korea, educational technology has been part of a long-term investment plan carried out irrespective of changing political administrations. It provides a brief overview on the progress of educational technology policy and how it differs from Latin American education policies, which lacked continuity and are affected by changes in political administrations.

This study explores whether the technology immersion model positively affects students learning outcome. While there was no significant effects on reading or math achievement, potentials of the model was detected.


In this study, students used the social networking platform Facebook in order to provide peer assessment for second language writing skills development. Students reported via interviews that this means for assessment was highly engaging and motivating.


This study examined the construct validity of the Survey of Preservice Teachers’ Knowledge of Teaching and Technology through an exploratory factor analysis (Shinas et al., 2013). The survey was given to 365 preservice teachers. The study confirmed that the constructs of TPACK as assessed by this instrument are not completely clear. The results showed that preservice teachers have difficulty assessing the nuances of this complex 7-factor framework.


Schulman’s AERA Presidential Address traces the earlier assessments of teacher qualification, focused on content knowledge, to the current focus on teaching procedures. He begins his framework for teacher education by distinguishing between content knowledge, pedagogical content knowledge, and curricular knowledge. Content knowledge “refers to the amount and organization of knowledge per se in the mind of the teacher” (p. 9), encompassing both the substantive and the structure of the content area. Pedagogical knowledge of teaching relates to the subject matter of teaching itself, and pedagogical content knowledge the best ways of teaching a particular content. Finally, curricular knowledge is an understanding of the tools with which teaching can be done, the instructional materials available, and the learner characteristics for which each tool is best suited.

Shulman’s foundation for teaching reform is grounded on observations of teachers and interviews with them, trying to synthesize and articulate what good teachers look like. He defines the teacher’s knowledge base as, at a minimum, including: “content knowledge; general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter; curriculum knowledge, with particular grasp of the materials and programs that serve as ‘tools of the trade’ for teachers; pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding; knowledge of learners and their characteristics; knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and knowledge of educational ends, purposes, and values, and their philosophical and historical grounds.” Shulman discusses the complexity of teaching in detail. He sets out a model of pedagogical reasoning and action from the perspective of the teacher that includes comprehension, transformation, instruction, evaluation, reflection, and new comprehensions.


The authors examine the effects of a one-to-one laptop initiative in the East Coast of the United States. Teachers and students reported benefits from this program including more individualized instruction, improved writing, and the development of digital literacy skills. The success of the program was also attributed to professional development for teachers.


This study attempts to define technological knowledge in teaching and learning contexts across various content areas.


This article discusses a teacher’s use of digital fabrication in an after-school setting to teach literacy through pop-up books at an urban middle school. The article uses the TPACK framework to discuss the author’s analysis of the process, but TPACK is not a proper framework in this context, which does not relate to teacher education at all. In
addition, the study does not consider whether or not increased content knowledge was achieved.


This paper explores the use of portfolios as an assessment method among college students. The authors suggest that portfolios are an efficient means for assessment; in particular the authors describe how best to convey portfolio expectations for students.


The authors use the theory of cognitive flexibility—the ability to think of two tasks or concepts at the same time, or to switch from one concept to another—informs our understanding of reading and learning in online environments. The hypertextual (e.g., links within pages) nature of online environments may require individuals to develop increased cognitive flexibility.

Spring, G. (2004). Australia’s future using educational technology. Canberra; DEST.

This report provides effective teaching and learning modes in technology-incorporated classrooms in Australia.


Based on the survey of MMOG players, the author argues that video games do not replace literacy activities; rather, this pop culture media is a part of literacy practices.


Discussion of the use of the RAT framework to think about new teaching tools and better implementing existing tools relating to math.


The authors explore the use of social networking sites by college students. They find that students used social media to build and maintain connections with family and friends and that in general, online and offline connections had significant overlap.

This study explores how a video case approach called the Case Technologies for Early Literacy Learning (CTELL) helps new teachers develop critical insights on integrating technology in literacy instruction. It introduces a set of 12 research-based principles that has guided the project and discusses the value of using video cases as a common anchor for instructors and students to construct knowledge through discussions of theory, research, and practice. Cases contain videos of classroom lessons and related materials that serve as a springboard for discussion, as a model, and as a practice tool. The authors argue that video cases involve sustained and repeated explorations of classroom instructional scenarios, ultimately supporting preservice teachers to understand and overcome the kinds of problems teachers encounter.


This summer camp attempts to promote the development of 21st Century learning skills and content knowledge (such as science and math) via “making.” Students engage in project-based activities that involve skills such as research, design, and testing.


This paper documents the results of a survey of 37 teachers who used LePress, a course management plug-in for the WordPress blog platform. The findings indicate that by using the tool, teachers experienced an enhanced level of control over several aspects of the course, which reinforced their perception about the ease of use of the system.


This report explores the increased affordances of web-based technology in learning environments, such as asynchronous learning, interactive simulations, direct links to resources, individualized coursework.


In this study with 468 primary school teachers, the authors attempt to identify determinants of supportive and class use of computers, based on demographic,
computer experience, and attitude variables.


This study compares the effectiveness of human tutoring, computer tutoring, and no tutoring.


Study of recently graduated math teachers. Discusses use of RAT as a framework for evaluation and thinking about pedagogical tools.


Good discussion of the value of taxonomies to help communication and understanding.


This study is a secondary analysis of teacher data from Second Information Technology in Education Study (SITES) 2006. Among 8th grade science teachers, Voogt compared extensive ICT using teachers, who used ICT once a week or more, to non-extensive ICT using teachers, who never used ICT in class. A T-test was used for statistical analysis and Cohen’s d was calculated for effect sizes. Generally, traditionally important curriculum goals (e.g., improving student performance in assessments) and practices (e.g., students working on the same learning materials at the same pace) were common among the science teachers than lifelong learning curriculum goals (e.g., fostering collaboration) and practices (e.g., advising students in inquiry activities). In addition, ICT was more often used for traditionally important teaching and learning practices than for lifelong learning teaching and learning practices. However, particularly the extensive ICT-using teachers attached more importance to curriculum goals that reflected a lifelong learning orientation than their non-extensive ICT-using colleagues (d = .56). The extensive ICT teachers also consider teaching and learning practices that reflected a lifelong learning orientation than their non-extensive ICT-using colleagues (d = .64).

Seminal work. The human mind is not understood without considering the surrounding society. The implications for education are discussed.


A study of a new reading tool, visual-syntactic text formatting, and its effects on students’ reading performance.


This report provides international data on the availability, use, and impact of educational technology in Asia. It aims to contribute to international benchmarking and monitoring of the integration of and access to ICT in education, which are fundamental for policymakers to select priorities and develop policies. Specifically, it examines the policy and curricular aspects of ICT in education, basic infrastructure required ICT-assisted instruction, and teacher preparedness in the selected Asian countries.


This study used computer and phone logging to track the technology usage of college students; the study found that patterns of use tended to vary between upperclassmen and lowerclassmen. The findings suggest that students may develop strategies for social media use over time.


Warschauer defines a framework for the digital divide. This article asks the question: what does it mean to be digitally literate? With examples from several cases, the author suggests that a top down, technocentric approach to technology education is less effective than a context- and community-based approach. He defines digital literacy as resources—physical, digital, human, and social resources—that are necessary to effectively use technology. Like Lankshear and Knobel, he suggests that digital literacy should not be thought of as a set of skills because it is a moving target that changes constantly with technology advances.

A three-year longitudinal case study in Egypt in which governmental agencies introduced ICT in the schools.


A study about the concept of social capital and its relationship to information and communication technology with a focus on the role of both micro-level and macro-level social capital.


This book discusses types of learning in one-to-one wireless classrooms with the focus on literacy practices, such as reading, writing, information use, and multimedia development.


A look at the information literacy and research practice at10 one-to-one laptop schools in California and Maine.


Discussion of research and best practices in using technology for education. Includes discussion of numerous studies and of TPACK framework.


The authors examine the implementation of the one laptop per child program in a Brimingham school by surveys, observations, and interviews, and identify factors that attributed to the disappointing results of the program.


The authors attempt to identify what contributes to digital divide.

This article describes how students from low-socioeconomic and underrepresented minority backgrounds tend to have less access to technology as well as fewer opportunities to practice the use of technology within the context of collaborative knowledge construction. Student technology skills vary widely across communities both in the US and globally. In order to address digital literacy development, educators must consider issues of equity—in terms of access, home and school practices, and in terms of available supports for students and their families.


This qualitative study examines how teachers and students use automated essay scoring software in classrooms. Data collected through interviews, surveys, and classroom observations is analyzed.


The authors note that “access alone is not enough to improve student outcomes” (p. 47), instead “it is the way in which students and teachers use technology that impacts learning” (p. 47). Indeed, individual teachers make or break 1-1 programs. "Differences in program deployment may have factored into whether obstacles to student access to, and engagement with, technology were overcome. Programs that examined the needs of their student and teacher populations, developed technology infrastructure, and sought support from stakeholders were more successful; the program that relied on technology alone to produce outcomes ultimately failed" (p. 58).


This study examines the effects of the West Virginia K-12 RuralNet Project on the long-term self-efficacy of in-service teachers and their use of the Internet in the classroom. The findings indicate that teachers’ level of self-efficacy improved after the summer workshops. Years of involvement in the program, combining an intense summer workshop with additional online courses, shows a significant difference in some aspects of self-efficacy over just having a professional development workshop.

In this study, Taiwanese college students, who used peer assessment, reported positive attitudes toward this alternative assessment form.


Using U.S. national data (the National Assessment of Educational Progress), the author explores the technology effectiveness on students’ performance in math, reading, and science.


The authors discuss frameworks for curriculum, instruction, and assessment. Focus on backward design, working from the desired learning outcome.


This paper describes experiences of Years 10 to 12 Australian students who participated in the Link ‘n Learn project for supporting chronically ill students’ learning by using technology.


This paper describes the experiences of Years 10 to 12 Australian students who participated in the Link ‘n Learn project for supporting chronically ill students’ learning by using technology.


This study investigates the ICT skills and knowledge of Scottish teachers and offers implications for teacher training and development.

Using the Goodyear, et. al., constructs of necessary competences for teachers interacting online, discusses staff development approaches based on levels of competences.


A two-year qualitative study of three middle school teachers during a laptop program adoption.


A study of a total of 62 preservice English teachers in Turkey who wrote reflective journals.


A survey study of families who received a home computer as part of the Tech Packs Project, an attempt to bridge the digital divide by providing computers to families that cannot afford it.


In this study of middle school students who had one-to-one computer access with netbooks and open source software, the authors explores how their collaborative cloud-based writing was aligned with the specific domains of the Common Core ELA Standards and discusses implications for practice.


This article graphs confidence intervals for 6 research studies using surveys to measure preservice teachers’ TPACK. The underlying survey at issue was the Schmidt et al. (2009) early childhood education survey on teachers’ knowledge of teaching and technology (TKT). The article includes a brief discussion of the history and criticisms of TPACK.

Graphing of confidence intervals for 6 research studies using surveys to measure preservice teachers’ TPACK. Not much insight provided.


This article provides an example of digital literacy practices at work within an online gaming community. The article explores peer-based learning and community development.


A study on theoretical and pedagogical issues around peer assessment


A study of elementary school teachers and their use of blogs in their classrooms.


This well written, conceptually strong article is on developing and validating a TPACK survey to assess secondary mathematics preservice teachers. It extends the TKT into secondary school and adapts the content area for mathematics. The surveys were done at 15 institutions and completed by more than 300 teachers. The results of the survey suggest that the instrument accurately captured the three main areas, technology, content, and pedagogical knowledge, but not the interrelated domains. The authors hypothesize that the intersections may be more difficult for preservice teachers to grasp because the constructs are complex and the preservice teachers are still learning the more general constructs. It is worth noting that the correlation between the four factors revealed that TK and PK have a low correlation, suggesting that they are, in fact, different constructs, while TPACK is correlated moderately with each of the three main constructs. The final 22 item-survey was found to be valid, reliable and manageable. Because the survey is intended to measure self-efficacy, and self-efficacy influence whether or not teachers can or will implement technology, the authors belief the self-report measure is useful.

Discussion of the process of developing a technology-based literacy scaffold for students with learning disabilities.


This is a study of K-12 students who used one-to-one laptop for two years. The authors discuss desirable perspectives on students in writing classrooms.


Study of daily access to laptops on the writing outcomes and processes of 2,158 upper elementary students in two school districts, and the effect among diverse students. In a California district, students showed improved English language arts achievement in both a partial laptop program year and a full laptop program year. In a Colorado district, overall writing test score gains were not statistically significant; however in both districts, at-risk student groups (i.e., Hispanics and low-income learners) showed significant gains. In addition, survey results, interviews, and observations indicate that at-risk learners used the laptops more frequently than their counterparts at school for a variety of learning purposes.