THE ROLE OF MULTIPLE SCAFFOLDS IN LEARNING DIGITAL LITERACIES IN A COMPUTER-SUPPORTED COLLABORATIVE LEARNING ENVIRONMENT

by

JEONGHUN OH

(Under the Direction of Janette R. Hill)

ABSTRACT

This study focuses on supporting students' digital literacy development in a technology integration course originally designed for pre-service teachers. Undergraduate students in three classes at a university in the Southeastern U.S. participated in this study. A mixed-methods study was implemented to analyze data from surveys, group interviews, participant products, and field notes of the researcher's observations.

First, this study investigated digital literacies reflected in the Technology Genius Project (TGP) in the technology integration course as well as participants' attitudes toward digital literacy education. The data from the surveys indicated that participants from all three classes had statistically significant growth in digital literacy competence and positive attitudes regarding digital literacy education in K-12 schools. The data from group interviews, participant products, and field notes of the researcher's observations indicated that participants from all three classes developed their digital literacies by participating in the tasks with authentic elements.

Second, this study explored the supporting role of multiple scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—in students' collaborative learning during the TGP. The findings indicated that participants found the multiple scaffolds useful or effective for their collaborative learning or digital literacy learning. Specifically, participants indicated that the collaboration guides facilitated their collaborative learning. In addition, question prompts and digital literacy resources provided a base for their collaborative knowledge building regarding digital literacies. Moreover, popular-culture resources were revealed to be relatable tools for most students' digital literacies learning. While the popular-cultural resources were not supportive for all student, they have the potential to support collaborative digital literacies learning given they are familiar to the instructor and students.

INDEX WORDS: Digital Literacies, Computer-Supported Collaborative Learning, CSCL Scripts, Scaffolds, Resources, Question Prompts, Popular-Culture Resources, Mixed Methods Study

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DEDICATION

This dissertation is dedicated to my mother, whose endless love and encouragement have sustained me throughout my life; to my wife, who has supported me with her love, faith, and sacrifice; to my son, who has been one of my best friends to me ever since I started my doctoral program.

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CHAPTER 1

INTRODUCTION

Many K-12 teachers in the United States teach in schools and classrooms enriched with media and technology-enhanced teaching tools (Hutchison & Reinking, 2011; Pittman & Gaines, 2015). Computers, the Internet, and a wide variety of educational technologies and software provide readily accessible information in current classroom environments (Pittman & Gaines, 2015). However, many of these same teachers do not know how to use various media and technologies in concert with meaningful learning activities to enable their students to develop desirable digital literacies (Kimmons, Miller, Amador, Desjardins, & Hall, 2015; Krumsvik, 2014; Tondeur et al., 2017; Wang, Hsu, Campbell, Coster, & Longhurst, 2014; Wastiau et al, 2013).

The under-developed levels of digital literacies for many educators constitute a major barrier to using various media and technologies in classrooms to support their students' learning (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hew & Brush, 2007; Krumsvik, 2014). As a result, even in today's technology-enhanced classrooms, many activities follow the tradition of audio-visual instruction that has long focused on delivering knowledge to learners rather than on enabling learners to use technology as cognitive tools to construct their own knowledge (Howland, Jonassen, & Marra, 2012) or as collaborative tools to interact with other people (Wang & Mu, 2017). As a result, many K-12 students may not have opportunities to use technologies for productive learning activities (Wang et al., 2014). This situation may be even more challenging for students in technology integration courses for pre-service teachers when they do not have sufficient opportunities to enhance their own digital literacies, which may be necessary to help their future K-12 students improve their digital competencies required for future careers and effective learning (Røkenes & Krumsvik, 2014; Tondeur et al., 2017).

Multiple literacies or digital literacies are important for today's K-12 students because most careers will expect them to use various media and technologies to communicate and collaborate effectively with people around the world (European Commission, 2006; European Commission, 2018; ISTE, 2016; Lin, Li, Deng, & Lee, 2013; Meyers, Erickson, & Small, 2013; New London Group, 1996). As digital technologies such as social media and the Web advance, traditional text-based literacies are not enough for effective communication (Lin et al., 2013). Students should understand how to deliver multimodal messages and information with appropriate media and technologies (Alvermann, Beach, & Boggs, 2016; New London Group, 1996).

Digital literacy education for students in technology integration courses is essential because many of them will enact digital literacy education in schools and transform school practices when they become teachers (Cervetti, Damico, & Pearson, 2006; Instefjord & Munthe, 2016; Krumsvik, 2014). It is important that educators have well-developed digital literacies because educators' digital literacies influence learners' digital literacies significantly (Krumsvik, 2014). Educators, including students in technology integration courses, need to understand how they can use media and technology meaningfully, what digital literacy means, and what kinds of digital literacies they and their students need to improve (Wang et al., 2014; Wastiau et al, 2013). Therefore, college of education programs should offer students in technology integration courses the necessary courses and learning activities to help them improve their digital literacies (Røkenes & Krumsvik, 2014; Tondeur, Aesaert, Prestridge, & Consuegra, 2018).

In addition to offering educational opportunities for students in technology integration courses, many researchers (Alvermann et al., 2016; Gee, 2015; New London Group, 1996; Street, 2008) seek to change in-school literacy practices. Digital literacy education programs for students in technology integration courses can be a starting place to change literacy practices in K-12 schools because students in technology integration courses will bring new literacy practices to schools (Cervetti et al, 2006). Therefore, it is important to reconsider the importance of digital literacy education for students in technology integration courses.

Although scholars indicate that students in technology integration courses can benefit from digital literacy education, there is a lack of research regarding learning environments and instructional strategies to improve students' digital literacies in technology integration courses. Several areas offer promise to fill the gap in how best to teach digital literacies to students in technology integration courses. First, students in technology integration courses can benefit from partaking in authentic digital literacy practices rather than learning specific skills (Reynolds, 2016). To serve the purpose of helping students participate in digital literacy practices, the kinds of digital literacy practice domains that specific groups of people (i.e., students in technology integration courses) need to learn should be identified (Reynolds, 2016). Because researchers define digital literacies differently and technologies develop quickly, it is important to establish the digital literacy practice domains in which certain groups of people engage (Reynolds, 2016). This identification of digital literacy practice domains will offer a base for students' participation in digital literacy practices in technology integration courses.

Second, the type of learning environments for the digital literacy development of students in technology integration courses need to be explored. One type of learning environment that seems promising is a computer-supported collaborative learning (CSCL) environment. CSCL environments can provide learners with technology-rich environments in which they can learn to integrate media and technologies with advanced pedagogical designs to enable student learning (Wang & Mu, 2017).

Finally, instructional scaffolds to support the digital literacy development of students in technology integration courses should be investigated (Kirschner, Wubbels, & Brekelmans, 2008; Krumsvik, 2014). Learners often need help with using media and technologies, but the desired degrees of collaboration often do not happen naturally in a classroom (Kollar, Fischer, & Hesse, 2006; Wang & Mu, 2017). Learners' collaborative activities supported by technologies can be facilitated by instructional scaffolds which guide collaboration procedures, resources, question prompts for subject learning, and group formation (Wang & Mu, 2017). In addition, this study investigates how popular-culture resources—another largely unexplored avenue to support students in technology integration courses as they develop digital literacy skills—support collaborative learning by gaining learners' attention, fostering linkages with domain knowledge, and offering common grounds for advanced learning activities (Alvermann, 2012)

The purpose of this study is to explore how students in a technology integration course originally designed for pre-service teachers construct knowledge of digital literacies and demonstrate their digital literacies in a CSCL with diverse scaffolds such as collaboration guides, question prompts, digital literacy resources, and popular-culture resources. I investigated the research questions described in the following section.

Research Questions

I designed a course unit in this study called the Technology Genius Project (TGP) to help students in technology integration courses improve their understanding of digital literacies as well as digital literacy skills by participating in authentic digital literacy practices in a CSCL environment. Through this study, I explored the students' experiences in technology integration courses with collaborative activities and diverse modes of scaffolds. I investigated the following questions:

1. How do the instructional scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—support collaborative activities during the Technology Genius Project?
2. What digital literacies are reflected in the Technology Genius Project in an undergraduate technology integration course?

Significance of the Study

This study is important for the following reasons. First, as shown in Figure 1-1, this study identified digital literacy practices for students in technology integration courses and explored the legitimacy of focusing on learners' participation in digital literacy practices through tasks that have authentic elements rather than learning and teaching a specific technology. Digital tools are ephemeral; therefore, focusing on popular tools today may result in learning a technology which is not used in the future (Reynolds, 2016). Furthermore, digital literacy practices are embedded and realized in socio-cultural contexts, just as discourses are (Gee, 2015). Therefore, this study investigated students' digital literacies in technology integration courses by helping the learners partake in digital literacy practices in social contexts.

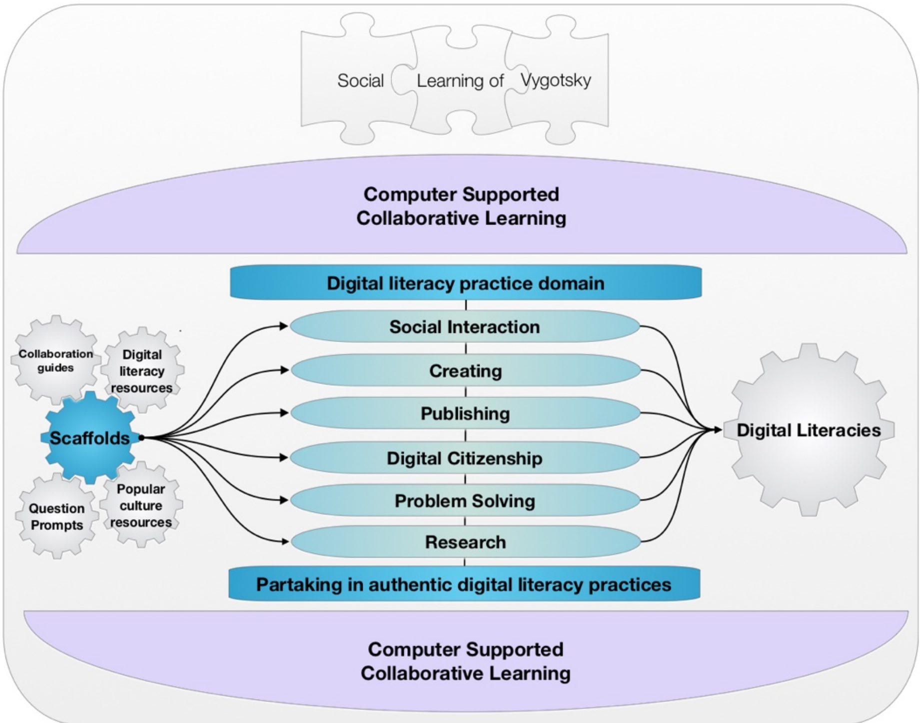


Figure 1-1. Conceptual framework for scaffolding students' digital literacy development in CSCL.

Second, as indicated in Figure 1-1, this research study investigated the legitimacy of the CSCL environment as a learning environment that facilitates student digital literacy development in technology integration courses. As mentioned earlier, there are not many research studies regarding student digital literacy development in technology integration courses in CSCL environments even though it appears reasonable that CSCL environments can offer effective environments in which students in technology integration courses can learn diverse media and technologies from social interaction with peers and instructors. For digital literacy development, it is required that students in technology integration courses understand digital literacy practices and become familiar with incorporating diverse media and technologies. To meet this necessity, learning environments such as CSCL have great potential to enable the kinds of learning opportunities that students in technology integration courses require to develop their own digital literacies.

Finally, this study investigated how instructional scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—could be deployed to support collaborative learning activities in CSCL. Because literacy practices are implemented in social and cultural contexts, and students in technology integration courses need to learn diverse digital literacy practices through social interaction, collaborative activities should be beneficial for student digital literacy development in technology integration courses. However, learners need guidance in collaboration because collaboration often does not occur naturally, and effective collaboration in technology-rich environments is complex. Therefore, this study examined how instructional scaffolds could be provided to organize collaborative learning activities in learning digital literacies.

Subjectivity Statement

In this section, I explain my personal background, expertise, experiences, and beliefs about learning because they inevitably influence my research interests and interpretation of learning. To begin, I am an international student from South Korea and have been studying in the U.S. for the past three-and-a-half years. I taught English for 12 years in South Korea and worked for the Smart Education Center in Busan, Korea for a year before I came to the U.S. As for my academic background, I have a dual bachelor's degree in English education and sociology, and a master's degree in English education, both from Korean universities.

My personal, professional, and academic backgrounds together have influenced my research interests. As a former English teacher and English education major, I saw many underused or unused digital resources in my field; also, I witnessed some of the benefits of collaborative learning in my field, but much of the collaboration was not designed and supported in intentional and robust ways. Various interactive platforms, such as blogs and YouTube, mobile phones in the hands of my previous Korean students, and social media made me realize how aspects of literacy education have greatly changed. Furthermore, I have also seen Web 2.0 platforms, mobile phones, tablet PCs, and computers facilitating learning processes through social interactions. My experiences as a former English teacher have led me to investigate the topic of improving digital literacies through collaborative learning processes.

As a former program coordinator for the Smart Education Center in Busan, Korea, I saw the importance of improving the digital literacies of teachers, students, and parents. They needed guidance on how to use media and technologies for learning and living. However, they did not have many opportunities to learn how to use media and technologies in productive ways. Teachers, students, and parents need educational programs to improve their digital literacy knowledge and skills just as students need guidance with their writing skills. As a result of my experiences with the Smart Education Center, I became interested in digital literacy courses for students in technology integration courses.

Finally, as an international student and a sociology major, I see the importance of cultures in communication and learning. I value educational perspectives that respect learners' diverse cultures and that are open to incorporating them into educational activities. I believe that students' out-of-school cultures are valuable resources for school activities, and validating students' out-of-school cultures makes school activities relevant and meaningful for students.
I have a socio-cultural perspective on learning. I believe that human beings learn through social interaction just as babies learn how to speak through social interaction with their parents. I am aware that collaboration facilitates learning and helps learners achieve cognitive development.

Therefore, I tend to focus on how I can support collaboration to help students learn better in CSCL environments. My personal background, experiences, and beliefs about collaborative learning and digital literacies may influence my perspectives on viewing and analyzing data in this study. I recognize the importance of reviewing my biases before, during, and after analyzing the data in the study and interpreting them.

Overview of Chapters

The presentation of the study is organized in six chapters. In the earlier sections of this chapter, I introduced the background of the problem, specified two research questions, and described the significance of the proposed research study. In Chapter 2, I discuss the conceptual framework regarding the concept of digital literacies and collaborative learning. In addition, I also review literature in the context of digital literacy education, CSCL environments, collaboration guides, question prompts, resources, and popular culture. In Chapter 3, I introduce a digital literacy project designed for this proposed study and describe how I implemented the project in a CSCL environment. I also introduce the mixed-methods study which was utilized during this study, describe the participants, and provide the descriptions of this study. In Chapter 4, I present the results and findings associated with the first research question: the supporting role of multiple scaffolds. In Chapter 5, I present the same materials associated with the second research question: students' digital literacy development. In Chapter 6, I interpret the results and findings, provide my suggestions for research and practice, and end with a conclusion.

CHAPTER 2

REVIEW OF THE LITERATURE

In this chapter, I start with a review of literature related to the concept of digital literacies and collaborative learning in CSCL environments, which provided a conceptual framework for conducting the current study and designing the learning environment for students' digital literacy development in technology integration courses. Next, I present a literature review regarding students' digital literacies in technology integration courses, instructional scaffolds in CSCL, and popular-culture resources.

Conceptual Framework of Digital Literacies

As mentioned earlier, the current study focused on helping students in a technology integration course participate in digital literacy practices with the help of multiple scaffolds. Therefore, the first step of this research project was to define digital literacies and identify digital literacy practices for students in technology integration courses. It is difficult to define digital literacies because various researchers emphasize different aspects of digital literacies according to their points of view and the foci of their research. Therefore, the definitions of digital literacies are diverse. For example, the term *digital literacies* shares common ground with other terms such as multiple literacies (Cervetti et al., 2006), multiliteracies (New London Group, 1996), media literacy (Lee, Chen, Li, & Lin, 2015), digital competency (Ferrari, 2013), ICT competency (UNESCO, 2011), and new literacies (Gee, 2015). The diversity of terms illustrates how widely traditional print-based literacy has been extended as technologies develop.

In this study, I define digital literacies as *mastery of media and technology tools and digital practices according to social contexts*. My definition is an adaption of Reynolds' (2016) definition of digital literacy: "mastery of technology tools and digital practices" (Reynolds, 2016, p. 736). Through my definition of digital literacies, I underscore the role of media and social contexts in digital literacy practices. I also use *digital literacies* instead of *digital literacy* to emphasize diverse digital literacy modes and practices (see Alvermann, 2011).

In the following two sections, I discuss the meanings of *mastery of media* and *technology tools and digital practices in social contexts* presented in my definition. In addition, in the process of discussing the detailed meanings of digital literacies, I also explain the importance of communication and collaboration using media and technology.

Mastery of Media and Technology

It is necessary to differentiate media from digital technology to properly understand the aspects of using media and technology in education (Reeves, 1998). I define media as "all means of communication, whatever its format" (Reeves, 1998, p. 1) and technology as "any object or process of human origin that can be used to convey media" (Reeves, 1998, p. 1). In these definitions of media and technology in education, communication is a keyword because media is used for communication while technology for media delivery. Therefore, it is necessary to emphasize the importance of communication in digital literacy courses in technology integration courses.

Communication with media and technology. Communication is defined as "Who says what, to whom, over what network, with what effect?" (Hoban, 1977, p. 58). Because of the existence of diverse media, however, I adapt Hoban's definition to define communication as: Who says what, to whom, *with which media,* over what network, with what effect?

Communication using diverse media and technologies is complex, as shown in a reproduction of Shannon's (2001) communication model (see Figure 2-1). Figure 2-1 suggests that learners with digital literacies can deliver messages to a desired destination by selecting adequate types of media and technologies that can reduce noise that hinders effective communication.

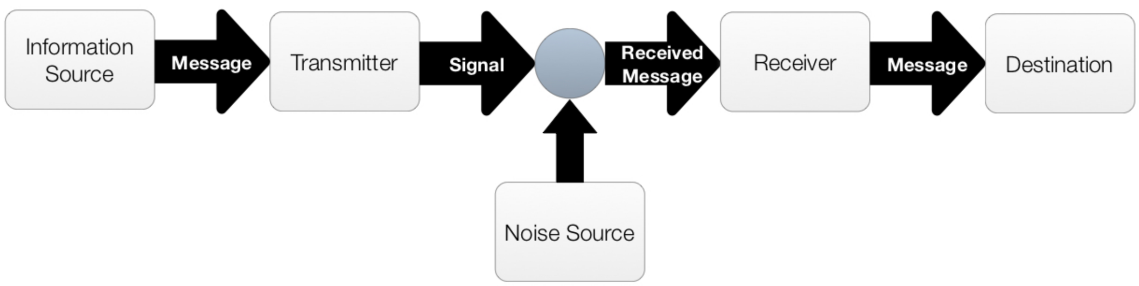


Figure 2-1. Schematic diagram of a general communication system. Adapted from "A mathematical theory of communication," by C. E. Shannon, 2001, *ACM SIGMOBILE Mobile Computing and Communications Review*, *5*(1), p. 4.

As technologies advance, some aspects of communication have changed. The aspects of communication in the Web 1.0 era is explained well with Shannon's (2001) communication model shown in Figure 2-1, which demonstrates one-directional flow of messages. The Web 1.0 era, which was brought to life by Tim Berners-Lee in the European Laboratory for Particle Physics in Geneva had a revolutionary effect by connecting information through hypertext documents (Wang & Mu, 2017). This resulted in the world-wide growth of Web sites and influenced how humans interact with information (Wang & Mu, 2017). Nevertheless, in the Web 1.0 age, the active producers of information and knowledge were people who had relationships with Web developers or Web administrators (Lee & Markey, 2014). However, the evolution of the Web from its 1.0 beginnings changed the aspect of interaction between humans.

Communication and collaboration in Web 2.0. In contrast to Web 1.0, in the Web 2.0 age, every Web user can disseminate information and knowledge through various forms of media such as audio, videos, and images by using Web applications such as social media, wikis, Flickr, blogs, and YouTube (Lee & Markey, 2014). As Web technology develops, interaction between human beings through the Web has become more active (Wang & Mu, 2017) and Web culture has become more participatory (Jenkins, Ito, & boyd, 2015; Lotherington & Jenson, 2011; Meyers et al., 2013). The distinctively interactive Web, which was called Web 2.0 by O'Reilly (Wang & Mu, 2017), means that learners have more capabilities to no longer be passive receptors of information but active producers of information. The nature of Web 2.0 that allows users to share and build knowledge has great potential to help learners improve 21^{st}-century skills "such as collaboration, communication, and critical-thinking skills, as well as digital literacy" (Sadaf, Newby, & Ertmer, 2016, p. 38).

Attributes or affordances of media and technology provide new ways to approach teaching and learning (Kozma, 1991). The technological affordances of the Web 2.0 age suggest the need to help learners communicate, collaborate, and partake in information sharing with media and technology (Wang & Mu, 2017). However, many classrooms still focus on individual knowledge building rather than collaborative knowledge (Wang & Mu, 2017). Educators' understanding of the affordances or attributes of media and technologies influences teaching methods (Kozma, 1991). Therefore, students in technology integration courses can benefit from building knowledge and skills regarding the interactive nature of Web 2.0 technologies.

Digital Literacy Practices

Researchers have tried to delineate the meanings of digital literacies and offered various frameworks for digital literacies such as the contemporary learning practices framework

(Reynolds, 2016), ISTE standards for students (ISTE, 2016) and teachers (ISTE, 2017), and DIGCOMP (Ferrari, 2013). Reynolds (2016) suggested that researchers need to offer digital literacy frameworks identifiable for each practice area. I have synthesized these four frameworks and standards for the purpose of creating a set of proposed digital literacy practice domains (DLPDs) for students in technology integration courses (see Table 2-1).

Table 2-1

Comparison of Digital Literacy Components in Four Different Frameworks and Standards

<table>
<tr><th>Reynolds (2016)</th><th>ISTE (2016)</th><th>ISTE (2017)</th><th>Ferrari (2013)</th></tr>
<tr><td>Create</td><td>-</td><td>-</td><td>Content Creation</td></tr>
<tr><td>Manage</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Publish</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Socialize</td><td>Creative Communicator/Global Collaborator</td><td>Leader/Collaborator /Facilitator</td><td>Communication</td></tr>
<tr><td>Research</td><td>Empowered learners/Knowledge constructors</td><td>Learner/Analyst</td><td>Information</td></tr>
<tr><td>Surf/Play</td><td></td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>Innovative Designer</td><td>Designer</td><td rowspan="2">Problem solving</td></tr>
<tr><td>-</td><td>Computational Thinker</td><td>-</td></tr>
<tr><td>-</td><td>Digital Citizen</td><td>Citizen</td><td>Safety</td></tr>
</table>

The most noticeable common element among the four different frameworks and standards is social interaction (communication or collaboration). These frameworks and standards recognize the importance of using media and technology for the purpose of direct communication or collaboration. Furthermore, other elements such as manage, publish, research, surf, problem solving, digital citizen, information, empowered learners, and problem solving, which can be viewed as social practices, also require communication or collaboration in the process of achieving the goal of each practice. Therefore, these frameworks and standards confirm that communication is a key factor in digital literacy practices. Based on the frameworks and standards in Table 2-1, I identified digital literacy practice domains (DLPDs) for students in technology integration courses (see Table 2-2).

Table 2-2

Digital Literacy Practice Domains for Students in technology integration courses

Digital Practice Domains		Media / Technology Activities
Social Interaction	Communication, collaboration, project planning, project management	Communicating with multimedia/Collaborating in creating wiki pages, Google Docs documents, and maps
	Helping students with social interaction	
Creating	Invention, creation, and completion of a digital project stemming from an original idea	Creating digital artifacts such as images, audio, videos, and Web sites.
	Helping students create the digital project	
Publishing	Publishing, distribution of self-created digital artifacts to an audience, community of peers	Sharing various media/Publishing digital artifacts through appropriate platforms such as YouTube and blogs
	Helping students with publishing practice	
Digital citizenship	Managing digital identities, maintaining privacy and security	Using media properly according to contexts/Establishing professional identities on Twitter
	Helping students establish digital citizenship	
Research	Research, inquiry, information seeking, and information management	Conducting research with diverse research tools
	Helping students conduct research	
Problem solving	Solving problems with design and computational thinking	Designing webpages with adequate images and effective arrangement of components
	Helping students become problem solvers	

As shown in Table 2-2, I included the four most common elements in DLPDs: social interaction, research, problem solving, and digital citizenship for students in technology integration courses. In addition, I added the *creating* domain to DLPDs for students in technology integration courses because both ISTE (2017) and Ferrari (2013) specified the importance of educators' competency in creating learning contents and environments using technologies. Finally, I added the *publishing* domain to DLPDs because educators and students can become active producers in the participatory culture of the Web (see Jenkins, Ito, & boyd, 2015; Lotherington & Jenson, 2011; Meyers et al., 2013) when they are able to publish their idea and artifacts. As a result, I have identified six DLPDs for students in technology integration courses as shown in Table 2-2.

Digital Literacy Practices in Social Contexts

Digital literacy practices are not individual but social acts because all the meanings of spoken words, written texts, and multimodal messages depend on social contexts. The view of digital literacies as a social practice challenges the autonomous model of literacy, which argues that literacy is independent of social systems and human beings' thoughts (Street, 2008). The social practice view of digital literacies is closely associated with the ideological model of literacy, which underscores literacy's dependence on social and cultural contexts (Street, 2008). Therefore, the social practice view of digital literacies argues that digital literacies are socially mediated by being embedded in specific social or cultural contexts (Street, 2008). This view of digital literacies as social practices reinforces the necessity of embedding digital literacy courses in social contexts in which learners join an authentic participatory culture of the Web (see Jenkins, Ito, & boyd, 2015) and communicate and collaborate with each other using diverse media and technologies.

Digital literacy practices involve more than merely combining media with technology. Social interaction through media and technologies is a part of big D Discourses, which Gee (2015) explains as how one says, reads, writes, behaves, values, and believes in order to be accepted as a member of a group. Discourses, including digital literacy practices, are associated with identities (Gee, 2015), which means participating in digital literacy practices requires an enhanced understanding about how people use media and technologies to interact with each other. Therefore, learners can benefit from digital literacy courses in which they can establish their identities in authentic social contexts and interact with each other using media and technologies.

In the next section, I review literature related to students' digital literacies in technology integration courses in order to investigate their digital literacy competency in general.

Students' Digital Literacies in Technology Integration Courses

Just over a decade ago from the present, NCATE (2008) specified the importance of pre-service teacher education in terms of technology integration into instruction. In addition, ISTE (2017) and the European Commission (2018) also recognized the importance of educators' digital literacies. Current students in technology integration courses are often called digital natives because they have grown up with digital media and technology (Ng, 2012; Prensky, 2001). However, not much is known about how digitally literate students in technology integration courses are as digital natives and how students in technology integration courses adopt unfamiliar educational technology when they learn. Furthermore, there is a lack of research on how to improve students' digital literacies in technology integration courses (Hutchison & Reinking, 2011). We need to explore what current students' digital literacies in technology integration courses are like and how to develop their digital literacies. In the next section, I explore current students' digital literacies in technology integration courses.

Students in Technology Integration Courses as Digital Natives

It is often said that digital natives learn differently because of information and communication technologies around them (Prensky, 2001; Wang & Mu, 2017). Furthermore, some scholars propose that digital natives are already well versed in using digital technology for communicating with others and searching for information through digital technologies for personal purposes (Prensky, 2001). However, some researchers have argued (Kirschner & De Bruyckere, 2017; Lei, 2009; Wang et al., 2014) that the technological knowledge and skills of digital natives are not deep because their familiarity with digital tools is limited to basic tools such as emails, chatting tools, and social media. In addition, studies have revealed that students in technology integration courses who are immersed in digital technologies are not prepared for meaningful integration of technology into education (Johnson, 2012; Sun, Strobel, & Newby, 2017). These studies suggest that students in technology integration courses need guidance regarding their digital literacy development as future educators.

Ng's (2012) study showed aspects of digital natives by showing how undergraduate students in technology integration courses used digital tools. For example, they were not afraid of using unfamiliar technologies (Ng, 2012). In addition, they tended to spend most of their time in creating content and integrating the content into technologies rather than struggling with learning how to use unfamiliar technologies (Ng, 2012). However, Ng (2012) also indicated that undergraduate students in technology integration courses needed help with how to use technologies meaningfully in education. Therefore, research studies including Ng (2012) suggest that students in technology integration courses can benefit from systematic digital literacy education, which helps them become active producers of digital artifacts and design meaningful lesson plans by using diverse Web 2.0 tools. In the next section, I describe how students' understanding of using digital tools in technology integration courses can be improved.

Students' Digital Literacy Development in Technology Integration Courses

Organizing digital literacy courses for students in technology integration courses is very complex (Tondeur et al., 2012). The following explanation of digital literacies indicates the complicated nature of digital literacies:

> Digital Competence is the set of knowledge, skills, attitudes, abilities, strategies and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socializing (Ferrari, 2012, p. 30).

Ferrari's (2012) description of digital competence is aligned with the digital literacy practice domains (DLPDs) of this study because, as previously mentioned, DIGCOMP (Ferrari, 2013) is one of the primary references for DLPDs. Ferrari's (2012) explanation of digital literacies reveals the complex nature of digital literacies and clarifies that digital literacy is not just about learning digital media and technologies (Instefjord & Munthe, 2016) but also about engaging in communication, collaboration, sharing, participating, and socializing. Digital literacy programs need to improve learners' "knowledge, attitudes, and skills" for using media and technologies (Ferrari, 2012, p.18). In addition, students in technology integration courses can also benefit from improving the knowledge of how to teach K-12 students with digital tools (Instefjord & Munthe, 2016; Mishra and Koehler, 2006; Tondeur et al., 2017), which adds a complex factor to the already complicated nature of digital literacy education.

The complex nature of students' digital literacy development in technology integration courses results in diverse digital literacy courses (Lee & Lee, 2014). For example, some researchers (Kist & Pytash, 2015; Sheridan-Thomas, 2006) focus on raising students' awareness and attitudes about using digital media and technologies for education through project experiences or reflective activities such as discussion and learning logs. Other researchers (Baran, Bilici, Sari, & Tondeur, 2017; Mishra & Koehler, 2006) focus on the technological knowledge of educators along with pedagogical and content knowledge. In the next section, I will review literature associated with students' digital literacy courses in technology integration courses and meaningful integration of media and technology into education.

Improving knowledge and skills about digital literacies. Students in technology integration courses can benefit from possessing knowledge and skills to participate in digital literacy practices and help their future students adequately engage in new modes of literacies. As discussed above, the definition of digital literacy knowledge and skills is the *mastery of media and technology tools and digital literacy practices according to social contexts*, which was adapted from Reynolds' (2016) definition. I define digital literacy knowledge as *understanding of media and technology tools used for digital literacy practice domains of a specific area*. Digital literacy skills refer to *implementing digital literacy practices of a specific area using media and technology tools*. Students can improve their digital literacies by partaking in digital literacy practices rather than learning how to use specific tools (Reynolds, 2016).

In a similar way to Reynolds (2016), Mishra and Koehler (2006) also pointed out the inappropriateness of focusing on teaching specific tools—which are ephemeral—without contexts. The technological pedagogical content knowledge (TPACK) framework (Mishra & Koehler, 2006) suggested that technology integration becomes meaningful when educators' content knowledge and pedagogical knowledge are combined with their technological knowledge. Therefore, students in technology integration courses can benefit from learning technological knowledge and skills by engaging in tasks in which they use technologies in authentic and meaningful contexts.

As a specific way of improving teachers' technological knowledge and skills, Koehler and Mishra (2005) suggested the *learning by design* approach, which is strongly against mainly teaching how to use specific tools but encourages learners to design artifacts to solve real-world problems. Their views regarding how to improve technological knowledge and skills are aligned with socio-constructivists' view of digital literacy (see Reynolds, 2016), which places emphasis on social contexts of digital literacies. They proposed that learners build technological knowledge and skills during the processes of designing artifacts such as online courses.

The *learning by design* approach (Koehler & Mishra, 2005; Mishra & Koehler, 2006) has been applied to improve in-service and pre-service teachers' technological knowledge as well as pedagogical and content knowledge. For example, Iskeceli-Tunc and Oner (2016) helped in-service teachers improve Web skills such as searching and evaluating skills through a WebQuests design task in association with pedagogical knowledge of developing higher-order thinking. The results and findings indicated that the design activity helped the learners improve Web searching skills as well as evaluating skills. In addition, the learner-designed WebQuests indicated that they included pedagogical elements to help improve higher-order thinking.

In addition, in Agyei and Voogt's (2012) study, pre-service math teachers collaboratively designed lesson plans to offer solutions to problems in math education. They expected that the collaborative lesson plan design incorporating spreadsheet technology would give the pre-service teachers ideas for using technologies contextually without considering technology incorporation itself as a purpose. The results and findings indicated that the design task in a math classroom context helped the learners learn how to use spreadsheets to help K-12 students learn math concepts and engage in an authentic mathematical task. In addition, the collaborative design gave learners the opportunity to improve their knowledge and skills of using spreadsheets in education by sharing information and ideas with team members.

TPACK and the *learning by design* approach (Koehler & Mishra, 2005; Mishra & Koehler, 2006) offer a very useful framework and strategy to improve students' digital literacies in technology integration courses. However, it is difficult to find deep discussions regarding what technological knowledge and skills mean, what digital literacies refer to, and what practices students in technology integration courses engage in using media and technology. This indicates that TPACK and the *learning by design* approach can benefit from new literacy studies (Gee, 2015) and digital literacy frameworks such as DIGCOMP (Ferrari, 2013), ISTE (2016, 2017), and the framework provided by Reynolds (2016).

Meaningful integration of technology. TPACK and the studies associated with the *learning by design* approach (Koehler & Mishra, 2005; Mishra & Koehler, 2006) indicated that it is not enough that students in technology integration courses improve technological knowledge and skills without knowing how to integrate media and technologies meaningfully for education. In addition, as discussed previously, research studies regarding digital natives also revealed that most of them do not know how to use technology meaningfully in education (Graham, Tripp, & Wentworth, 2009; Ng, 2012; Sun et al., 2017). Therefore, technology integration courses need to provide students with guidance regarding how to design meaningful activities by incorporating technologies.

Regarding meaningful integration of technology, Howland et al. (2012) provided very clear answers by offering a conceptual framework for creating meaningful learning activities. First, just as Jonassen and Reeves (1996) and Reeves (1998) did, they differentiated *learning from technology* and *learning with technology*. *Learning from technology* means that learners mainly receive information and knowledge from technology (Howland et al., 2012; Jonassen & Reeves, 1996; Reeves, 1998). They were against mainly using technology to deliver knowledge and information to learners in traditional learning environments. Instead, they recommended taking a *meaningful learning with technology* approach when incorporating technologies in education.

Learning with technology means using technology for knowledge construction, conversation, articulation, collaboration, and reflection (Howland et al., 2012). Technologies in the approach of *learning with technology* are considered cognitive tools (Ottenbreit-Leftwich & Brush, 2017; Reeves, 1998) or intellectual partners (Howland et al., 2012). Learners engage in productive thinking with the support of technology in the environment of the *learning with technology* approach (Howland et al., 2012). This approach is contrasted with audio-visual instruction and CAI which focused on delivering information to learners (Reeves, 1998).

For realizing meaningful *learning with technology* in a classroom, Howland et al. (2012) suggested adopting five attributes of meaningful learning—intentional, active, constructive, cooperative, and authentic learning—in activity design. This means that technology is being used to support knowledge construction by allowing learners to explore information using technology in authentic, collaborative, and goal-oriented learning environments (Howland et al., 2012). This approach is in juxtaposition with learning environments in which learners become passive receptors of information and knowledge (Howland et al., 2012) and can guide students from diverse backgrounds in technology integration courses in terms how they can integrate technology meaningfully.

However, it is difficult to find research studies in which Howland et al.'s (2012) concept of meaningful integration of technology is adopted. Instead, many research studies are based on the TPACK framework and the *learning by design* approach. For example, Mouza, Karchmer-Klein, Nandakumar, Yilmaz Ozden, and Hu (2014) helped pre-service teachers improve technological knowledge in association with content and pedagogical knowledge through the *learning by design* approach. Learners collaboratively designed lesson plans where Web 2.0 tools were integrated and then implemented into their lesson plans in K-12 classrooms. The results indicated that pre-service teachers improved technological knowledge in combination with content and pedagogical knowledge.

Even though the *learning by design* approach in Mouza et al.'s (2014) study was legitimate and seemed effective for improving pre-service teachers' TPACK, the study did not seem to guide pre-service teachers to creating lesson plans in which technologies were meaningfully integrated in the way Howland et al. (2012) suggested. This could possibly lead to pre-service teachers' lack of knowledge regarding meaningful integration of technology because, as mentioned in earlier sections, researchers (Johnson, 2012; Ng, 2012; Sun et al., 2017) indicated that students in technology integration courses often do not know how to use technology meaningfully in education. Reeves (1998) and Howland (2012) suggested that educators, including students in technology integration courses, can benefit from understanding technologies as cognitive and productive tools rather than as mainly delivering information. Therefore, incorporating Howland et al.'s (2012) meaningful integration of technology with the *learning by design* approach can help students in technology integration courses understand what meaningful learning with technology is.

Improving attitudes about digital literacies. In addition to digital literacy knowledge and skills as well as knowledge about meaningful integration of technology, students in technology integration courses can also benefit from forming positive attitudes toward learning digital literacy practices and digital literacy education in K-12 schools. Attitude refers to the mental tendency toward certain behaviors (Bai & Ertmer, 2008; Davis, 1985). This definition indicates that a positive attitude regarding digital literacy will result in the actual use of technology in the classrooms (Davis, 1985; Davis, 1989; Knezek & Christensen, 2016).

The Technology Acceptance Model (see Davis, 1985), the Will, Skill, Tool, and Pedagogy model (see Knezek & Christensen, 2016), and the Technology Integration Model (see Holland & Piper, 2014) all proposed that attitudes toward technology influence the adoption of technology in classrooms. Among them, the Technology Acceptance Model suggested that perceived ease of use regarding technology would influence perceived usefulness of technology, and then perceived usefulness would influence attitudes toward using technology (Davis, 1985; Davis, 1989). This model indicated that learning environments in which learners can recognize the usefulness of technology due to its ease of use can influence learners' attitude toward adopting technology in classrooms.

The association between learning usefulness of technology and positive attitudes toward technology also indicates that learners can form positive attitudes by improving digital literacy knowledge and skills in technology integration courses. For example, Baturay, Gökçearslan, and Ke (2017) investigated the relationship between pre-service teachers' computer competence and their attitudes toward technology integration into education. The results indicated that there was a strong positive relationship between them. As Davis (1985) also suggested, perceived usefulness, enjoyment, and perceived ease of use has a positive effect on attitudes toward technology integration into education. The Technology Acceptance Model and Baturay et al.'s (2017) study imply that students in technology integration courses can improve their attitudes toward digital literacies by improving their digital literacy knowledge and skill and then recognizing the ease and usefulness of technology.

In addition to research studies regarding educators' acceptance of technology, new literacy studies associated with educators are also concerned with raising educators' awareness towards ever changing modes of literacy as a social practice and helping educators have positive perspectives about incorporating new practices of digital literacies (Cervetti et al., 2006; Lotherington, & Jenson, 2011). New literacies are closely associated with digital literacies because they both focus on humans' new practice of using digital media and technologies (Ng, 2012; Meyers et al., 2013). Digital literacies from a new literacy perspective define literacy broadly and put less emphasis on specific skills about technologies and more emphasis on participation in digital literacy practices (Meyers et al., 2013), which explains why social aspects of literacy practices are emphasized in new literacy studies (Greenhow & Gleason, 2012). Therefore, the best way to improve digital literacy from a new literacy perspective is to participate in digital literacy practices in social contexts (Meyers et al., 2013).

Many educators, however, still do not have positive attitudes about incorporating new modes of literacy practices into formal classrooms. For example, many teachers do not think that it is important to adopt new forms of digital literacy practices such as chatting through messenger apps and writing on blog and wiki platforms (Hutchison & Reinking, 2011; Kist & Pytash, 2015). Even students in technology integration courses often have negative attitudes about adopting digital literacy practices in education, although it is often assumed that they as digital natives would incorporate new modes of literacy practices due to their strongly positive beliefs in digital literacy practices.

For example, Kist and Pytash's study (2015) exemplified pre-service English teachers' perceptions of new literacies in two methods courses and addressed students' ideological aspects regarding literacies in technology integration courses. The two method courses in the Kist and Pytash's (2015) study were connected to field experiences, and the authors analyzed research participants' interviews, blog posts, in-class responses, and survey responses. The findings in their study are surprising and demonstrate the necessity for digital literacy education for students in technology integration courses. At the initial stage of the research, the authors expected that the pre-service teachers, as digital natives, would integrate new literacies into English classrooms smoothly. The authors also assumed that they would see tensions about literacy practices between students in technology integration courses and in-service teachers who were not digital natives.

In the research results, however, Kist and Pytash (2015) experienced the tension between students and researchers regarding their thoughts about new literacies. The authors found that when students in technology integration courses went on a school experience, their learning in the method courses did not significantly affect their thoughts about new literacies in schools. They explained that traditional thoughts about literacy were strongly situated in students' ideologies in technology integration courses. This suggests that students in technology integration courses need well-organized digital literacy programs to break out of harboring traditional ideologies regarding literacies.

Kist and Pytash (2015) observed that many teachers did not consider new literacies practices using Web 2.0 technologies such as wikis and blogs were important enough to be taught in schools. With regard to helping students in technology integration courses develop positive perspectives about digital literacy, it is worthwhile to note their recommendations of providing opportunities for pre-service teachers to reflect on their beliefs on new literacy practices. Kist and Pytash's (2015) study revealed the need to investigate students' awareness and beliefs in technology integration courses regarding digital literacies.

I now turn to the task of exploring how to measure digital literacy in the next section.

Measuring Digital Literacies of Students in Technology Integration Courses

New Literacy Studies such as Kist and Pytash's (2015) and Sheridan-Thomas's (2006), which investigated students' ideologies and practices regarding literacies as a social practice, often follow qualitative research designs and do not measure digital literacies regarding technological knowledge and skills quantitatively. However, research studies focusing on technological skills of learners often measure digital literacies quantitatively (Reynolds, 2016). There are three types of tools for measuring digital literacy: (a) measuring frequency of utilizing technologies in education; (b) focusing on conceptual frameworks of using technologies; (c) measuring performance of using technology for education (Tondeur et al., 2017).

Measuring digital literacies based on certain groups of technology skills is problematic because it is only valid for a certain period of time when those particular technologies are used. For example, Chien, Chang, Yeh, and Chang (2012) measured pre-service science teachers' knowledge and skills regarding Flash software to investigate the effect of a design framework called MAGDAIRE. For 18 weeks, pre-service teachers learned how to design online science courseware using Flash software in a technology integration course for science teachers. Because tools such as Flash can suddenly disappear or not be used widely anymore, it may not be meaningful to focus on and measure the knowledge and skills of specific tools that are popular at specific times (Reynolds, 2016).

Measuring digital literacies based on the frequency of utilizing certain technology can be also problematic. For example, Siiman et al. (2016) measured 6th and 9th grade students' digital competency based on their frequency of using smart devices such as smartphones and tablet computers for information, communication, and content creation areas. The results of this study demonstrated the aspects of smart device usage for the three specified areas based on the

DIGCOMP framework. However, it is difficult to say that the frequencies per se indicate students' digital competency because the association between frequency of use and digital competency may not be as strong as some researchers believe it to be.

Reynolds (2016) proposed a social constructivist digital literacy framework as an alternative to skills-based digital literacy measuring practices. The social constructivist digital literacy perspective focuses on humans who use technologies to design and create artifacts rather than ephemeral specific technologies (Reynolds, 2016). This approach of emphasizing human purposes of using technology enables researchers to create their own frameworks reflecting diverse contexts in which technologies are used (Reynolds, 2016). Therefore, researchers and educators create their own digital literacy practice domains (see Reynolds, 2016) and develop measuring tools to assess learners' digital literacy based on the digital literacy practice domains created.

In regard to focusing on human practices rather than technology (Reynolds, 2016), measuring educators' digital literacy through their performance can be a viable method, especially when learners have the opportunity to implement the lesson plans in K-12 schools. For example, Graham et al. (2009) assessed pre-service teachers' work samples, which are called Teacher Work Sample (TWS). In their study, pre-service elementary school teachers created a unit plan in which they integrated technologies with pedagogical goals and implemented their unit plan in elementary schools.

The findings from the analysis of TWS in Graham et al.'s (2009) study indicated that pre-service teachers mainly used technology for creating lesson plans and presenting information to students rather than using technology for facilitating students' active learning. However, when pre-service teachers were guided adequately by field instructors and TWS rubrics in the second iteration, their performance of using technology noticeably improved in the area of using technology for their students' active learning. The findings indicated that pre-service teachers need proper guidance on how to use technology meaningfully. As shown in the analysis and findings in Graham et al.'s (2009) study, assessing students' designed work can be an operable method of investigating how they incorporate technology in education.

Regarding measuring pre-service teachers' ICT competency, Tondeur et al. (2017) developed a self-report instrument. They identified two factors for pre-service teachers' ICT competency: (1) competencies for helping students use technology in classrooms and (2) competencies for using technology for designing instruction. The validated survey items provide ways to measure pre-service learners' self-perceived competency in helping K-12 learners engage in active learning activities using technology for communication, collaboration, and conducting research. In addition, the survey items can also measure pre-service teachers' capabilities of incorporating technology for designing learning environments. As Tondeur et al. (2017) indicated, the survey items can be used to measure ICT competency without referring to specific technology.

The literature presented in this section indicated that there is no consensus regarding measuring digital literacies. Therefore, it can be useful to take the strengths from each method of measurement and combine them to investigate learners' digital literacy development. For example, it can be useful to identify digital literacy practice domains of students in technology integration courses (Reynolds, 2016), assess their performance in the identified digital literacy practices (Graham et al., 2009), and measure students' perceived digital literacies in helping students use technology and designing instruction (Tondeur et al., 2017).

In the next section, I describe the association between digital literacy development and

CSCL environments as a learning environment to support learners' systematic use of media and technologies in collaborative processes.

Facilitating Digital Literacy Development in CSCL Environments

As discussed earlier, media and technologies are defined in terms of communication (Reeves, 1998), and digital literacy practices are social practices (Gee, 2015). In addition, multiple digital literacy frameworks commonly suggest that communication and collaboration are key elements for digital literacy development. In the *learning by design* approach to improve educators' TPACK, collaborative learning through design teams is often considered as an important approach to developing technological knowledge (see Agyei & Voogt, 2012; Koehler, Mishra, & Yahya, 2007; Johnson, 2012; Mouza et al., 2014). This emphasis on collaboration occurs because collaborative learning environments help learners find effective ways of integrating technology (Baran & Uygun, 2016) and engage actively in meaningful and contextual knowledge building activities (Johnson, 2012). The concepts of media, technologies, and digital literacies, as well as collaborative learning in the *learning by design approach,* indicate that digital literacy development can be facilitated in interactive environments in which learners communicate and collaborate with media and technologies.

The communicative and collaborative learning environments, which are supported by media and technology, are in alignment with the characteristics of CSCL environments, which I describe in the following sections in detail. Collaboration inevitably involves interaction between peers (Dillenbourg, 1999; Jeong & Hmelo-Silver, 2016), and CSCL environments support the interaction between peers with computers (Wang & Mu, 2017). The characteristics of CSCL environments, which support social interaction with media and technologies, indicate the possibility of CSCL environments as an adequate learning environment for digital literacy development for students in technology integration courses.

In CSCL environments, media and technology are organized to support collaborative interaction in CSCL (Jeong & Hmelo-Silver, 2016). For example, Table 2-3 summarizes Jeong and Hmelo-Silver's (2016) explanations regarding technological affordances in CSCL. This means that students in CSCL environments can learn how to use media and technology for communication, collaboration, and regulation by engaging in collaborative work in these environments.

Table 2-3

Technological Affordances in CSCL

Aspects	Description
Collaborative tasks	Multiple media and technologies such as simulation and Wikipedia can provide organized environments in which learners engage in meaningful collaboration.
Communication	Synchronous and asynchronous communication technologies such as chatting tools and discussion boards can help overcome restrictions of organizing collaboration between learners from distant places.
Resources	Tools such as web pages, databases, and applications can help learners access, share, and manage resources.
Structuralizing collaborative learning processes	Media and technology can contribute to providing patterns of collaboration by distributing effective collaborative settings and regulating activities through regulatory scaffolds such as multiple prompts.
Facilitating co-construction	Tools such as online forums and shared workspaces (e.g., Google Docs) can facilitate learners' co-construction of knowledge.
Monitoring and regulating	Showing student performances and activities through visualization tools and analytical tools helps students monitor and regulate their activities.
Finding and building communities	Learners can build learning communities easily and effectively through tools such as social media and feedback systems

As Table 2-3 shows, media and technologies play an important role in supporting learners' communication, collaboration, and regulation of their learning activities. Therefore, learners can be immersed in the learning environments in which media and technologies are being used meaningfully for communication and collaboration in CSCL environments. In the following sections, I will review the literature related to CSCL environments and ways to support interactions to facilitate collaborative activities in CSCL.

Conceptual Framework of Collaborative Learning

As discussed earlier, CSCL environments can fit well with technology integration courses because CSCL environments pursue supporting communicative and collaborative learning with the support of media and technology. However, it is difficult to find literature which discuss how CSCL environments can facilitate digital literacy development with the support of multiple scaffolds. In this section, I present the concept of collaborative learning from the perspective of CSCL and theories supporting collaborative learning as well as CSCL environments as a possible learning environment for students' digital literacy development in technology integration courses.

Aspects and Definition of Collaborative Learning

Collaborative learning is a key concept in CSCL, and students in technology integration courses can benefit from learning in CSCL because they are expected to interact with each other and create products using technologies. However, collaborative learning involves complex processes (Damon & Phelps, 1989; Dillenbourg, 1999). Even though the value of collaborative learning has been widely accepted (Zheng, Niiya, & Warschauer, 2015) and even though collaboration is regarded as a common term, many aspects of this term must be considered, including its definition. Based on aspects of equality and mutuality, collaborative learning is differentiated from cooperative learning and peer tutoring (Damon & Phelps, 1989). Table 2-4 summarizes Damon and Phelps's (1989) comparison of collaborative learning, cooperative learning, and peer tutoring in terms of equality and mutuality. Learners in collaborative learning are both equal and mutual to each other in the highest (Damon & Phelps, 1989). However, cooperative learning is relatively low in mutuality (Damon & Phelps, 1989; Dilenbourg, 1999). Therefore, in cooperative learning, learners often distribute work to partners and put together the individual work to complete the final work (Dilenbourg, 1999).

Table 2-4

Equality and Mutuality in Peer Education

Aspects	Collaborative learning	Cooperative learning	Peer tutoring
Equality	high	high	low
Mutuality	high	low	low

When learners work in collaboration, they work together with high mutuality and equality to achieve common goals (Damon & Phelps, 1989; Dillenbourg, 1999; Dillenbourg, Baker, Blaye, & O'Malley, 1995; Jeong & Hmelo-Silver, 2016). However, despite this simple explanation about collaboration, collaborative learning is a much more complex topic. For example, Dillenbourg (1999) suggested a more extended view of collaborative learning by stating the complexity of defining collaboration and argued that collaborative learning needs to be inspected in terms of four elements: situation, interactions, mechanisms, and effects. Table 2-5 summarizes Dillenbourg's (1999) explanations regarding collaboration in terms of these four elements.

Table 2-5

Four Elements Needing Inspection in Collaborative Learning

Elements	Description
Situation	• If learners with similar knowledge and status levels engage in symmetrical actions to achieve shared goals, a situation can be more collaborative. • When learners work together with a lesser degree of division of work, a situation can be more collaborative.
Interactions	If learners negotiate to work together synchronously and interactively, they influence other learners' cognitive learning processes, and their interactions are more collaborative.
Learning Mechanisms	• Collaborative learning often involves inductive learning and is associated with cognitive load reduction caused by a horizontal division of work and cognitive load increase caused by interacting with each other. • Explanation and conflict in social settings are involved in collaborative learning processes. • Internalization processes occur in collaborative learning by transferring tools from social interaction to an individual dimension of reasoning.
Learning Effects	The elements mentioned above regarding collaboration indicate the complexities of collaborative learning and research studies that investigate the effects of collaboration should make clear which specified interaction they explore in exploratory environments.

In addition to the aspects of mutuality and equality in collaborative learning, Dillenbourg (1999) described the processes of learning in collaborative settings and the considerations for research studies regarding the effects of collaboration. These elements, especially the first three elements in Table 2-5, help define what collaborative learning is: collaborative learning refers to phenomena in which learners engage in an interactive learning mechanism by sharing workload to achieve common goals (Dillenbourg, 1999). This definition of collaborative learning indicates that students in technology integration courses in CSCL environments are expected to accomplish shared goals by participating in interactive learning activities. Regarding the last element, it would be beneficial to investigate why collaboration can facilitate learning and how collaboration in education can be supported, which I review in the next sections.

Theoretical Perspectives in Collaborative Learning

Theoretical foundations of students' digital literacy development in CSCL can be found in constructivist perspectives on learning. Constructivists emphasize learners' construction of knowledge to explain how learning takes place. There are three different views regarding knowledge construction among constructivists: dialectical constructivism, endogenous constructivism, and exogenous constructivism (Moshman, 1982; Schunk, 2008). Among them, dialectical constructivism and endogenous constructivism can explain how learning occurs through social interaction in collaborative learning (Lipponen, 2002). However, exogenous constructivism emphasizes the importance of the external world in learning rather than social interaction (Schunk, 2008). Therefore, in the following sections, I describe Piagetian theory and Vygotsky's theory, which represent endogenous constructivism and dialectical constructivism (Moshman, 1982), respectively, as supporting theories for collaborative learning.

Piagetian theory. Piagetian theory indicates that learners in technology integration courses can develop their digital literacy knowledge and skills by interacting with peers. Piaget explained that learners achieve cognitive development by constructing individual knowledge (Moshman, 1982). According to Piaget, their cognitive development typically follows specified stages: sensorimotor, pre-operational, concrete, and formal operations (Moshman, 1982; Rieber, 1996). The processes of cognitive development in Piagetian theory are explained by assimilation and accommodation processes, which show the mechanism of how learning occurs (O'Donnell & Hmelo-Silver, 2013; Rieber, 1996).

According to Piaget, learning is the process of constructing schemes through the assimilation and accommodation processes (Rieber, 1996). Cognitive development occurs when learners assimilate new events through existing knowledge structures (O'Donnell & Hmelo-Silver, 2013; Rieber, 1996). Learners can also accommodate new learning events by modifying existing knowledge structures (O'Donnell & Hmelo-Silver, 2013; Rieber, 1996). Therefore, Piagetian theory of cognitive development suggests that cognitive development is the process of learners' dissolving cognitive conflict or disequilibrium through assimilation and accommodation mechanisms (Lipponen, 2002; O'Donnell & Hmelo-Silver, 2013; Rieber, 1996).

Piaget's theory of cognitive development may be seen as lacking emphasis on the socio-cultural influence on learning because it focuses on individual cognitive processes of knowledge construction (Rieber, 1996). However, Piaget's theory can explain how students learn in contact with peers (Lipponen, 2002). For example, when students encounter other peers, they can experience cognitive conflict or disequilibrium, which leads to assimilation and accommodation processes (Lipponen, 2002). Therefore, Piaget's theory explains how cognitive development occurs in individual minds (Lipponen, 2002) and implies that CSCL environments can facilitate students' digital literacy development in technology integration courses by offering learning environments in which students can undergo cognitive disequilibrium and assimilation processes.

In contrast to Piaget's theory, Vygotsky's socio-cultural theory emphasizes the socio-cultural aspect of learning, as shown in the following section.

Socio-cultural theory. Vygotsky's socio-cultural theory offers theoretical foundations for students' digital literacy development in CSCL with multiple scaffolds. Vygotsky's socio-cultural theory is closely related to dialectical constructivism (Schunk, 2008; Wang & Mu, 2017). While endogenous constructivism such as Piagetian theory considers learning as consisting of individual processes rather than social processes, Vygotsky's socio-cultural theory emphasizes social interaction in learning, which is essential in collaborative learning in CSCL environments (Lipponen, 2002). According to socio-cultural theory, cognitive development occurs when learners mutually engage in the knowledge construction processes with the support of cultural tools (Lipponen, 2002). This socio-cultural orientation is important for both digital literacy education and CSCL environments because, as previously mentioned, communicating and collaborating using media and technologies are a part of the Discourses humans engage in to be accepted as a group member (see Gee, 2015).

In addition to recognizing the socio-cultural nature of learning, understanding how scaffolding in collaborative learning can occur is also important because natural collaboration of students in education is difficult to achieve (Dillenbourg, 1999: Du, Yu, & Olinzock, 2011). The importance of scaffolding in collaborative learning can be best explained with the concept of zone of proximal development, which is described in the next section.

Zone of proximal development and scaffolding. Vygotsky (1978) explained that learners achieve their cognitive development through social interaction by proposing his concept of zone of proximal development (ZPD). The concept of ZPD provides theoretical foundations for supporting students' digital literacy development with instructional scaffolds in technology integration courses. ZPD is one of the key concepts in Vygotsky's cognitive development theory. ZPD also explains how social interactions are the primary factors in learning. According to Vygotsky (1978), ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). The concept of ZPD suggests that if teachers provide proper learning conditions through social interactions, learners can achieve cognitive development within their ZPDs (Doolittle, 1995).

Achieving cognitive development within ZPD requires guidance in learning (Schunk, 2008; Stone, 1998). One form of guidance is instructional scaffolding, which helps learners develop within their ZPDs (Verenikina, 2003). It is not clear who used the metaphor *scaffold* to first explain the support by other learners and adults, but Wood, Bruner, & Ross (1976) used the term *scaffolding* extensively in their article to explain that scaffolding helps learners achieve cognitive development through such processes as solving problems and performing tasks beyond their current capabilities (Stone, 1998). Instructional scaffolding has been used in diverse learning contexts such as literacy education and science education (Belland, 2014). Although Vygotsky did not address scaffolding formally, the concept fits well with ZPD (Schunk, 2012).

Although the notion of scaffolding originally referred to support provided by more knowledgeable persons (Wood, Bruner, & Ross, 1976), it has evolved to include emergent modes of scaffolding (Puntambekar & Hubscher, 2005). These emergent modes of scaffolding include peer-to-peer scaffolding and computer-based scaffolding. Furthermore, the notion of scaffolding now includes tools and resources provided to learners to assist learning and distributing various scaffolds systematically is emphasized (Puntambekar & Hubscher, 2005). Finally, the evolved notion of scaffolding includes permanent supports without calibration and fading, which are applied for all students (Puntambekar & Hubscher, 2005).

The aspects of instructional scaffolds can also be divided into social scaffolding and technological scaffolding (Pea, 2004). Social scaffolding is associated with Vygotsky's emphasis on social interaction in learning, and technological scaffolding is related to Vygotsky's views of tools such as languages, symbols, and technologies as playing a supporting role in learning (Pea, 2004). Therefore, scaffolding can include questions from instructors, course structures, and computer software (Pea, 2004).

According to Schunk (2008), instructional scaffolds have the following features: (a) provide support; (b) function as a tool; (c) extend the range of the learner; (d) permit the attainment of tasks not otherwise possible; and (e) can be used selectively as needed. In addition, scaffolds have diverse functions according to purpose (Hannafin, Land, & Oliver, 1999). For example, to help learners achieve cognitive development within their ZPDs, educators can offer various types of scaffolds that Hannafin, Land, and Oliver (1999, p.117) suggest as follows:

- Domain-specific versus generic scaffolds
- Conceptual scaffolding (guidance on what to consider)
- Metacognitive scaffolding (guidance on how to think about the problem under study)
- Procedural scaffolding (guidance on how to utilize resources and tools)
- Strategic scaffolding (guidance on approaches to solving the problem)

These types and functions of instructional scaffolds suggest that scaffolds in education are diverse types of interactions between more knowledgeable instructors or peers and learners (Sharma & Hannafin, 2007).

Table 2-6 summarizes Belland’s (2014) comparison of scaffolds and other simple supports. Scaffolding simplifies processes by structuring tasks (Reiser, 2004). For example, simplification can be achieved by decomposing complex tasks, focusing effort, and monitoring (Reiser, 2004). On the other hand, scaffolding can make students’ tasks more complex by problematizing. Problematizing helps learners focus on critical aspects of a task and to perform tasks adequately (Reiser, 2004). Finally, scaffolds are often created to temporarily support tasks

(Belland, 2014), but as mentioned earlier, the notion of scaffolding evolved to include supports without fading (Puntambekar & Hubscher, 2005).

Table 2-6

Differences between Scaffolding and Simple Supports

Scaffolding	Simple supports such as job aids
Provides both simplification of processes and emphasis on their complexity	Offer only simplification of processes
Addresses complex processes and knowledge	Only address simple procedures
Designed to be used temporarily during the scaffolded task	Designed to be used by individuals even after instructions

Roles of computers in CSCL. Theoretical background regarding the role of computers in CSCL can be found in socio-cultural theory of Vygotsky (1978). Along with social interactions with peers and teachers, tools such as language and technology influence human development (Vygotsky, 1978). A person's cognitive development is mediated by psychological tools such as languages and symbols in social environments (Blunden, 2017; Schunk, 2008) as well as technological tools such as computers in CSCL environments, which can play a role as tools in facilitating learning processes by supporting social interaction (Goodyear, Jones, & Thompson, 2014; Schunk, 2008).

As mentioned in the previous section, the mediating role of tools can be translated into a scaffolding role (Pea, 2004). Various types of tools, such as computer software and languages, prompts, hints, and resources, have been provided to support learning (Puntambekar & Hubscher, 2005). Although many researchers acknowledge the possibilities of technological tools to improve practices in education, there is a need for research studies to investigate how to use technological tools methodically to facilitate collaborative learning (Wang & Mu, 2017).

Script theory, which I describe in the next section, offers a theoretical foundation for using technological tools systematically by organizing collaborative interaction in education.

Script Theory and Collaborative Learning

As mentioned earlier, offering and distributing diverse scaffolds systematically can benefit learners (Choi, Land, & Turgeon, 2008; Puntambekar & Hubscher, 2005). Script theory provides a base for supporting collaborative interaction with systematic scaffolding. A script is defined as “a structure that describes appropriate sequences of events in a particular context” or “a predetermined stereotyped sequence of actions that defines a well-known situation” (Schank & Abelson, 1977, p. 41). Script theory can explain how humans can handle complicated situations that require social interaction. For example, humans in a restaurant often recognize where to sit and how to order, tip, and pay because of knowledge structures that allow them to perform the tasks in a restaurant without much effort (Schank & Abelson, 1977). Schank and Abelson (1977) explored questions such as how humans know to behave appropriately in a certain circumstance. Humans have a structure of knowledge, called a script, that guides human thoughts and behavior (Schank, 1999; Schank and Abelson, 1977).

Therefore, script theory indicates that collaborative learning can be supported by providing learners with structured sequences of activities. This support for learning by scripts is possible because scripts make it easier to handle certain situations with the minimal mental effort required to process the situations (Schank, 1999). Therefore, when learners do not have well-developed scripts in certain contexts, script theory suggests providing external scripts, which guide what they should do in a multitude of activities in education (Wang & Mu, 2017). External scripts can help learners participate in collaborative learning activities in diverse educational contexts more easily (Wang & Mu, 2017). Next, I describe what CSCL is and how collaborative learning can be supported in CSCL.

Computer-Supported Collaborative Learning Environments

In CSCL, researchers and educators pursue designing learning environments in which collaborative learning is facilitated with the support of computers. CSCL is described as "a learning environment in which a large amount of information can be accessed easily, and in which knowledge can be shared and co-constructed through communication and joint construction of products" with the support of computers (O'Donnell, Hmelo-Silver, & Erkens, 2013, p. 266). The characteristics of CSCL found in the definition are knowledge sharing, co-construction of knowledge, collaborative products, and support from computers. These characteristics of CSCL have the potential to facilitate students' digital literacy development in CSCL.

CSCL has the belief that students learn better when they share and construct knowledge together (Wang & Mu, 2017), and as explained earlier, the foundation of this belief lies in Vygotsky's socio-cultural theory that says learners construct their knowledge through social interaction with peers and teachers (Vygotsky, 1978). Web 2.0 environments, which enable learners to become interactive producers of knowledge (Wang & Mu, 2017) and benefit collaboration in workplaces (Hazari & Thompson, 2015), also offer the necessities of designing effective collaboration in learning with technologies.

The difference between CSCL environments and other collaborative learning environments is that computers support collaborative learning processes in CSCL by playing a mediating role in collaborative processes (Goodyear et al., 2014). The theoretical foundation and the role of computers in CSCL environments are found in Vygotsky's view that "learning is a social activity that is mediated by various tools" (Olivares, 2008, p. 32). In summary, CSCL suggests that learners construct their knowledge through collaborative interaction with other students, and computers support the collaborative processes. How collaborative learning is supported is explored in the next section.

Supporting Collaborative Learning in CSCL

CSCL environments usually focus on offering support for collaborative learning (Järvelä et al., 2004; Vogel et al., 2016) because collaboration in CSCL often does not happen naturally (Kirschner & Erkens, 2013). Learners need instructional support that guides collaborative processes (Weinberger et al., 2009). Therefore, learners in technology integration courses in CSCL environments can benefit from multiple scaffolds which support collaborative learning.

The multiple scaffolds can play the role of providing domain specific/generic, conceptual, metacognitive, procedural, and strategic supports (Hannafin et al., 1999). These scaffolds offer foundations for designing regulatory supports in CSCL environments (Järvelä & Hadwin, 2013) although the scaffolds are not designed specifically for collaboration. For example, Table 2-7 summarizes Järvelä and Hadwin's (2013) explanations regarding regulatory scaffolds in CSCL .

Table 2-7

Regulatory Scaffolds in CSCL

Scaffolds	Description	Example
Structural supports	Enhancing collaborative work by offering patterns for collaboration, such as role distribution and function description.	Structuring collaborative activities using wikis, smartphones, and face-to-face activities as shown in Laru, Näykki, and Järvelä (2012)
Mirroring and metacognitive tools	Facilitating learners' awareness of their work so that they could regulate and improve their work based on the information	Helping learners plan, perceive, and monitor their collaborative tasks through taking smartphone photos and publishing them to wikis as shown in Laru, Näykki, and Järvelä (2012)
Guiding systems	Computational algorithms analyze the activity data and offer guidance for collaboration	Showing activities that were not completed and asking learners to take particular collaborative actions

As Table 2-7 shows, regulatory scaffolds in CSCL can support collaborative learning by structuralizing collaborative processes, helping learners manage their work effectively using metacognitive strategies, and providing analytical information regarding learners' learning progress. In addition, Table 2-8 summarizes Kirschner and Erkens's (2013) explanation regarding providing supports with technology, materials, and intervention in CSCL. While the scaffolds in Table 2-7 are focused on regulatory support for collaboration, Kirschner and Erkens (2013) explained supports in CSCL in terms of the pedagogical, social, and technological elements. For example, epistemic prompts, group activity reflection tools, and communication tools can be offered to facilitate learning processes, support collaborative interaction, and help learners communicate effectively with technological support (Kirschner & Erkens, 2013).

Table 2-8

Providing Support in CSCL

CSCL elements	Functions	Examples
Pedagogical elements	Facilitating learning processes	Interactive tools, epistemic prompts, representations, and process worksheets
Social elements	Supporting collaboration and interaction	Social/group awareness tools and group activity reflection/group feedback tools
Technological elements	Supporting collaborative learning process with computers	Communication tools, such as chat tools and Skype, and productivity tools, such as a shared text processor

As Table 2-7 and Table 2-8 indicate, scaffolds in CSCL can be offered dynamically in multiple forms or elements. The common characteristics of scaffolds in CSCL found in the two tables are that scaffolds in CSCL are designed and provided to enhance collaborative processes and facilitate learning processes. In the next sections, I review the literature associated with specific ways to support collaboration in CSCL.

Supporting Collaboration with Collaboration Guides in the Form of CSCL Scripts

Support for collaboration in CSCL is often offered in the form of collaboration scripts (Kollar et al., 2006; Wang, Hou & Wu, 2016). Students' digital literacy development in technology integration courses in CSCL can be supported with multiple scaffolds in association with CSCL scripts. CSCL scripts are based on script theory, which was discussed in an earlier section and provides a theoretical foundation for supporting collaborative learning. CSCL scripts refer to instructional scaffolds that are created to help learners with the collaborative learning process in computer-supported learning environments (Weinberger et al., 2009). CSCL scripts are defined more in detail as "a set of instructions prescribing how students should form groups, how they should interact and collaborate and how they should solve the problem" (Dillenbourg, 2002, p. 61). CSCL scripts can guide learners by helping them understand the scenes that they are engaged in and take appropriate actions according to scenes (Kollar et al., 2006). Researchers describe the components of CSCL scripts in diverse ways, as shown in the following section.

Components of CSCL scripts. CSCL scripts provide patterns of collaboration in learning scenes to facilitate the collaboration process and can help students in technology integration courses achieve their collaborative goals by offering patterns of collaborative work. These patterns provide more elaborate guides on how learners should collaborate than educators' global or general instructions (Dillenbourg, 2002). Therefore, CSCL scripts define the collaboration process rather than provide content or guidance regarding knowledge (Weinberger et al., 2009). Kollar et al. (2006, p. 9) suggests five components of CSCL scripts: (1) learning objectives, (2) learning activity types, (3) activity sequence, (4) mechanisms of role distribution, and (5) types of representation (e.g., texts, audio, videos). These components can be considered as patterns of collaboration. If scripts offer patterns of collaboration to learners, learners can engage more effectively in the learning processes.

Similarly, Fischer, Kollar, Stegmann, and Wecker (2013) suggest that CSCL scripts comprise plays, scenes, scriptlets, and roles after dividing CSCL scripts into internal scripts and external scripts. Internal scripts refer to knowledge of collaborative practices, and external scripts facilitate collaborative activities by supporting internal scripts (Fischer et al., 2013; Wang & Mu, 2017). The components of external scripts can be explained in the following: (a) *play* components in external scripts specify the goal of collaborative activities; (b) *scene* components delineate a group of scenes in which learners play to achieve the goal; (c) *role* components specify roles to play for participants; and (d) *scriptlet* components explain the patterns and procedures of activities in scenes (Fischer et al., 2013; Wang & Mu, 2017).

While internal scripts are a part of learners' existing knowledge and experiences, external scripts are independent of learners' schemata (Kollar, Fischer, & Slotta, 2007). To facilitate collaborative processes, external collaboration scripts can be provided in various forms such as teachers' oral or written instructions and computer applications (Fischer et al., 2013). External collaboration scripts bring positive effects to collaboration practices when they provide affordances that help learners choose their internal collaboration scripts effectively (Fischer et al., 2013).

Table 2-9 summarizes Kobbe et al.'s (2007) descriptions regarding the five components of CSCL scripts. Kobbe et al. (2017) suggested that the five components are organized and structuralized through script mechanisms: task distribution, group formation, and sequencing. Through the task distribution mechanism, participants know what to do with which resources (Kobbe et al., 2007). In addition, participants are guided to form groups through group formation mechanisms which direct them to form groups according to certain criteria or methods (Kobbe et al., 2007). Finally, a sequencing mechanism give order to activities by showing which activities take place at certain phases (Kobbe et al., 2007).

Table 2-9

Components of CSCL Scripts

Components	Description
Participants	Scripts specify requirements regarding participants. For example, scripts will describe the number of total participants and each group.
Activities	Scripts describe activities, and each activity can be composed of sub-activities. According to the difficulties of activities, different degrees of scaffolds will be provided.
Roles	Participants will be informed of activities they are supposed to complete or resources which are distributed to them through scripts.
Resources	Resources are distributed to participants as online materials or physical forms.
Groups	Scripts explain group formation methods considering the learner characteristics or other criteria.

The CSCL script components shown in Table 2-9 indicate that students' digital literacy development in technology technology integration courses in CSCL can be supported with script mechanisms which systemize CSCL components. These components of CSCL scripts can be specified according to the structure of CSCL script specification, which I discuss in the following section.

Specification of CSCL scripts. CSCL components need to be provided in a structuralized form to students. Dillenbourg (2002) described how to specify CSCL scripts with five elements: phases, task, group, mode, and timing (Dillenbourg, 2002). CSCL scripts are often composed of sequenced phases like "Script = [phase1 phase2 phase 3 …]," and each phase comprises five attributes such as task, group, mode, distribution and timing, which can be expressed as "Phase = [Task Group Mode Timing]" (Dillenbourg, 2002, p.71). The third attribute, distribution, is specified under the task and group attributes (Dillenbourg, 2002).

CSCL scripts in each phase specify task in the form of "[input activity output]" (Dillenbourg, 2002, p.71). After students receive information, they engage in activities and produce their works (Dillenbourg, 2002). CSCL scripts describe how groups are formed, and group formation and size can be different at each phase according to group formation criterion (Dillenbourg, 2002). CSCL scripts also specify how tasks are distributed to each group and what modes of collaborative interaction are needed in each phase of tasks (Dillenbourg, 2002). Finally, CSCL scripts manage the timing of collaborative activities by specifying activity duration and the deadline for task completion (Dillenbourg, 2002).

According to which aspects of collaboration CSCL scripts support, they are divided into macro scripts and micro scripts (Dillenbourg & Jermann, 2007; Wang & Mu, 2017). Macro scripts refer to the specification of a sequence of collaborative learning activities, and micro scripts refer to detailed guides in specific activities (Hernandez-Leo, Villasclaras-Fernandez, Asensio-Perez, Dimitriadis, & Retalis, 2006). Therefore, while micro scripts guide learners with specified directions, such as question prompts, macro scripts are more aligned with coordinating collaboration indirectly through group formation guidance and goal and task specification (Wang & Mu, 2017).

Roles and effects of CSCL scripts. CSCL scripts can structuralize how to use media and technologies effectively for collaborative interaction (Wang & Mu, 2017). Analyzing technological affordances for supporting collaborative learning (Jeong & Hmelo-Silver, 2016) can be helpful for specifying CSCL scripts. Specified CSCL scripts guide learners about diverse aspects of collaborative learning processes.

More specifically CSCL scripts can facilitate collaboration by offering guidance about CSCL components, such as details of participants, activities, role specifications, and resources (Kobbe et al., 2007). In addition, CSCL scripts streamline collaboration processes through mechanisms of forming groups, sequencing tasks, and structuralizing activities, roles, and resources (Kobbe et al., 2007). Therefore, CSCL scripts support collaboration by specifying patterns of collaborative activities.

Research studies specifically focusing on the supporting role of CSCL environments and CSCL scripts in digital literacy courses are lacking in the literature. However, the research results in Table 2-10 suggest that collaboration scripts have significant effects on collaborative processes or learning outcomes. CSCL research on collaboration scripts often compares scripted collaboration conditions with non-scripted ones as Table 2-10 describes.

Table 2-10

Findings of Research on Collaboration Scripts in CSCL

Study	Context	Analysis / Research Design	Findings
De Wever, Hämäläinen, Voet, & Gielen (2015)	College students in Educational Sciences	Collaboration scripts for a wiki task / Control group (a non-scripted condition) vs. Experiment group (a scripted condition)	● Significant positive effects on collaboration processes and shared responsibility. ● No significant effects on wiki products ● No significant effects on learning outcomes
Judele, Tsovaltzi, Puhl, & Weinberger, (2014)	Undergraduate teacher trainees in a Facebook app	Argumentative scripts / 22 design: Individual Preparation (with vs. without) and Argument Structuring (with vs. without)	● No significant effect of argument structuring ● Detrimental effect of individual preparation
Lee (2015)	College students	Collaboration scripts based on QRAC reading strategy / Control group (a non-scripted condition) vs. Experiment group (a scripted condition)	● Significant effect on students' reading literacy
Stegmann, Weinberger, & Fischer (2007)	Undergraduate students' online discussion	2 × 2-factorial design (with vs. without scripts for the construction of single arguments and with vs. without scripts for the construction of argumentation sequences)	● Improvement in quality of argument ● Facilitation of acquiring argumentation knowledge ● No effect on domain-specific knowledge
Valtonen et al. (2015)	Pre-service science teachers' attitudes toward the use of ICT	The analysis of the effects of a collaborative and inquiry-based course on pre-service teachers' attitudes	● Significant increases in self-efficacy and subjective norms ● No differences in attitudes
Vogel et al. (2016)	Analysis of 22 articles regarding research on CSCL scripts	A meta-analysis of 22 articles in terms of effects for domain-specific knowledge and collaboration skills under the consideration of moderators, such as transactivity, script level, and content-related support,	● Substantial enhancement of CSCL scripts on learning outcomes ● A small positive effect on domain-specific knowledge (d = 0.95) ● A large positive effect on collaboration skills (d = 0.95) ● Particularly effective for domain-specific learning

Among research studies in Table 2-10, the possibility of CSCL environments and CSCL scripts for facilitating students' digital literacies in technology integration courses can be found in De Wever et al.'s (2015) and Valtonen et al.'s (2015) study. First, De Wever et al. (2015) recognized the advantages of wiki-environments for collaborative knowledge building as well as the difficulties of making them productive collaborative learning environments. Therefore, they designed CSCL scripts that asked college students to read the given resources and edit specific wiki pages at each step.

The results of their study showed that the learner groups who followed CSCL scripts were more effective with collaborative work processes and felt more shared responsibility than non-scripted groups. Even though there were not statistically significant differences in learning outcomes, the results indicated that learners could engage in authentic social practices of publishing their collaborative knowledge by interacting with each other with the support of media, technology, and CSCL scripts.

Valtonen et al.'s (2015) study is also one of the rarer articles that indicated the possibility of CSCL environments supported by CSCL scripts for students in technology integration courses. They did not investigate CSCL environments, CSCL scripts, and pre-service teachers' digital literacy development in depth. However, their research demonstrated that CSCL environments could provide meaningful learning environments for pre-service teachers to use media and technologies systematically with the support of CSCL scripts.

For example, pre-service teachers focusing on science subjects in the study used a wiki environment, blogs, YouTube, and Facebook systematically to produce multimodal learning materials associated with an elementary school curriculum. Their systematic collaborative activities were guided by CSCL scripts offered through the wiki and blogs. The researchers expected that the pre-service teachers' experiences with meaningful collaborative activities in CSCL would increase their attitudes toward using ICT for teaching and learning. However, the already high pre-test scores resulted in results that were not statistically meaningful with regard to attitudes. Nevertheless, the results revealed a statistically meaningful increase in the pre-service teachers' self-efficacy and subjective norms regarding using ICT.

As shown in research studies in Table 2-10, CSCL environments and CSCL scripts focus on designing learning environments and supporting them so that learners can collaborate with each other effectively with the support of computers (Wang & Mu, 2017). The role of media and technologies in CSCL is crucial in supporting and regulating collaborative learning (Jeong & Hmelo-Silver, 2016). Digital literacy practices are also associated with implementing communicative and collaborative activities with the support of media and technologies (Ferrari, 2013; ISTE, 2016; Reynolds, 2016). The role of this common ground for students' digital literacy development in technology integration courses, which CSCL environments and digital literacy courses share, is difficult to find in literature, although CSCL environments provide adequate learning design in which learners can co-construct their knowledge regarding digital literacy practices by learning communication and collaboration digital literacy skills.

Therefore, researchers and educators can help students in technology integration courses facilitate their digital literacy development by designing CSCL environments in which students can participate in the authentic digital literacy practices of sharing their collaborative knowledge with the help of media and technology. Furthermore, CSCL scripts can support students' collaborative knowledge building activities regarding digital literacy practices by combining different types of scaffolds, such as prompts and resources. In the next section, I discuss how to support students' collaborative knowledge building activities in CSCL with these scaffolds.

Using Question Prompts in CSCL

Learners in CSCL environments often construct knowledge together (O'Donnell et al., 2013). This aspect of learners' knowledge construction in CSCL indicates that learners can benefit from instructional supports which facilitate their domain knowledge acquisition and collaborative learning processes. Prompts can play the supporting role in helping students in technology integration courses build their knowledge together regarding digital literacy practices. Prompts are instructional methods used to "induce and stimulate cognitive, metacognitive, motivational, volitional and/or cooperative activities during learning" (Bannert & Reimann, 2012, p. 195). Researchers often name prompts in diverse ways according to the purpose of prompts: knowledge integration prompts and problem-solving prompts (Chen & Bradshaw, 2007); generic reflection prompts and directed reflection prompts (Davis, 2003); procedural prompts, elaboration prompts, and reflection prompts (Ge & Land, 2004). According to the form or representation type of prompts, prompts can be divided into question prompts, sentence opener prompts, visual prompts, and so on (Ifenthaler, 2012).

Prompts are often used to facilitate peer interaction or collaborative learning processes (Bannert & Reimann, 2012; Choi, Land, & Turgeon, 2005; Choi, Land, & Turgeon, 2008; Morris et al., 2010), which indicates that prompts can fit well with one of the purposes of CSCL environments; that is, guiding the learners' collaborative learning with computers. Among diverse prompts, question prompts are forms of prompts to guide collaborative work more effectively (Ge & Land, 2004). Question prompts can be categorized into elaboration prompts, reflection prompts, and procedural prompts (Ge & Land, 2004). The purpose of reflection prompts lies in helping learners regulate their activities (Ge & Land, 2004). Elaboration prompts support learners so that they can advance their thoughts and produce explanations (Ge & Land, 2004). Finally, procedural prompts are created to guide learners to complete specific work in subject content (Ge & Land, 2004).

Choi, Land, & Turgeon (2005) and Choi, Land, & Turgeon (2008) suggested question prompts can help learners engage in deeper thinking and contribute to domain knowledge construction. The research studies specifically investigated the role of question prompts generated by peers in an online college course. Choi et al. (2005) revealed the necessity of scaffolding strategy to help learners create meaningful and constructive question prompts that contribute to other students' knowledge construction. As a result, Choi et al. (2008) modeled how to create question prompts that could contribute to other students' learning, through the instructor partaking in online discussion. The intervention of modeling creating question prompts resulted in improving the quality of question prompts by students. As a result, the peers' question prompts helped other students improve their initial answers. Choi et al. (2008) indicated that question prompts could facilitate learners' knowledge construction.

Prompts such as question prompts and sentence starters—in combination with macro scripts—can also guide collaborative learning activities in CSCL environments (Miller & Hadwin, 2015). However, research studies regarding prompts in CSCL are limited compared to the large amount of literature on CSCL scripts (Järvelä et al., 2016; Morris et al., 2010) because many CSCL studies focus on CSCL scripts in general rather than on the specific roles of prompts in CSCL scripts. Accordingly, it is even more difficult to find research studies focusing on question prompts in CSCL. Table 2-11 summarizes research studies associated with prompts in general as well as question prompts in collaborative learning environments.

Table 2-11

Supporting Collaborative Learning with Prompts

Study	Context	Analysis / Research Design	Findings
Du et al. (2011)	Graduate students / Offering question prompts to guide students' web-based inquiry	Investigating the effect of question prompts through the treatment and control group	● Students who were supported with question prompts received statistically high evaluations
Harney, Hogan, Broome, Hall, & Ryan (2015)	College students / Offering task-level prompts and process-level prompts	Assessing the effects of prompting style through ANCOVA tests	● Groups given process-level prompts marked significantly higher scores on perceived consensus and efficacy
Raes, Schellens, De Wever, & Vanderhove (2012)	Secondary science education / web-based collaborative inquiry learning / Offering scaffolds such as question prompts	Two-by-two factorial quasi-experimental design / Three different scaffolded environments were compared with a control condition	● Multiple scaffolding including prompts facilitate students' knowledge building and improved their metacognitive awareness
Weinberger, Ertl, Fischer, & Mandl (2005)	College students/ Offering epistemic and social scripts composed of prompts including question prompts in two studies: text-based peer discussion and video conferencing	Two-by-two factorial design: epistemic script (with vs. without) and social script (with vs. without)	● Social scripts substantially benefitted students' individual knowledge building, but epistemic scripts did not bring up significant results.

Among the studies shown in Table 2-11, Raes et al.'s (2012) study investigated the effect of multiple modes of scaffolds, such as technology-enhanced and teacher-enhanced scaffolding in the form of prompts, including question prompts, on secondary students' collaborative web inquiry in natural science classrooms. The researchers recognized the necessity of providing the scaffolds because web inquiry requires regulatory capability and metacognitive awareness for successful problem solving. The analysis results revealed that students in scaffolded conditions perform better in their collaborative web inquiry than those without scaffolds. The results indicated that scaffolding students' web inquiry in the form of prompts including question prompts could facilitate their domain knowledge.

Moreover, Harney et al. (2015) investigated task-level prompts and process-level prompts in regard to their effects on perceived consensus and efficacy and argumentation style in CSCL. College students in their study discussed the negative aspects of social media with the support of task-level and process-level prompts in the form of question prompts. According to the results, the groups given process-level prompts had statistically higher scores on perceived consensus and perceived efficacy. In addition, the groups displayed a wider spectrum of argumentation styles. These results indicate that learners in CSCL environments could benefit from prompts that include question prompts.

Similarly, Du et al. (2011) investigated the impact of question prompts on graduate students' collaborative problem solving through the Web. They provided question prompts for the treatment group during their online discussion activities. This treatment group who were guided by the question prompts received statistically higher evaluations than those without the question prompts. The results indicated that supporting collaborative learning with question prompts could have positive effects on students' collaborative learning.

The studies in Table 2-11 indicate that prompts including question prompts can benefit students in facilitating their collaborative working processes and learning outcomes. In the next section, I discuss resources as another scaffold in CSCL.

Resources as an Instructional Scaffold

As mentioned earlier, students in technology integration courses are expected to build digital literacy knowledge, skills, and pedagogical knowledge of technology integration.

Resources can contribute to helping students improve their digital literacy competency as an instructional scaffold by providing domain knowledge regarding digital literacy practices. Resources are widely defined as "media, people, places or ideas that have the potential to support learning" (Hill & Hannafin, 2001, p.38). However, resources in CSCL often refer to virtual or offline materials which are distributed to learners in CSCL environments in association with CSCL scripts (Kobbe et al., 2007). Kobbe et al. (2007) proposed that CSCL scripts are composed of participants, activities, roles, resources, and groups. This indicates that presenting and structuralizing resources is an important part for the success of collaborative learning (Jeong & Hmelo-Silver, 2016). For example, Ingulfsen, Furberg, and Strømme (2018) showed teacher-prepared resources were one of the important scaffolds used to guide secondary school students' collaborative science experiments and reports. MURDER script (Dansereau, 1988; O'Donnell & Dansereau, 1992) showed how resources could be used in collaborative and reciprocal learning between two partners (Kobbe et al., 2007). In addition, De Wever et al. (2015) also showed that resources were one of the key components in their CSCL scripts which helped college students build collaborative knowledge through wiki pages.

Resources can provide common ground for participants to work together in CSCL environments, and one of the mechanisms of CSCL script is to structuralize how to distribute resources to learners (Kobbe et al., 2007). For example, gStudy (Winne, Hadwin, & Gress, 2010) distributed organized resources regarding science topics through learning kits embedded in the gStudy software. In addition, in jigsaw types of collaborative learning such as those found in the study by De Wever et al. (2015), resources are distributed to learners so that they are dependent on each other to complete collaborative work (Kobbe et al., 2007). These studies indicate that resources are an integral part of CSCL scripts.

It is not enough to merely distribute resources to learners in CSCL. Learners are often guided on how to use resources as can be seen in gStudy (Winne et al., 2010) and the study by De Wever et al. (2015). It is difficult to find research studies which provide a structuralized view about how to help learners use resources in CSCL. However, Hill and Hannafin (2001) suggest that scaffolds, such as conceptual scaffolds, metacognitive scaffolds, procedural scaffolds, and strategic scaffolds, need to be provided to learners along with resources. These scaffolds help learners find out what is important (conceptual scaffolds), regulate their learning (metacognitive scaffolds), clarify how to use resources (procedural scaffolds), and find different ways to complete the task (strategic scaffolds) (Hill & Hannafin, 2001). These scaffolds can also benefit learners in their use of resources in CSCL.

Research studies investigating the effects of resources in CSCL are lacking in literature because CSCL research studies often explore how to design (Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2014), regulate (Splichal, Oshima, & Oshima, 2018), and support (Ingulfsen et al., 2018) collaborative learning processes using multiple scaffolds. However, as mentioned, resources comprise an important part of CSCL scripts. Table 2-12 summarizes the roles or usage of resources in collaboration scripts found in CSCL studies.

Table 2-12

Supporting Collaborative Learning with Resources in CSCL

Study	Context	The role of resources
Ke & Hsu (2015)	Improving Pre-service teachers' technological pedagogical content knowledge (TPACK) through AR through CSCL	This study used mobile media resources and AR artifact creation activities to investigate their roles in improving TPACK. The results showed mobile media resources supported CK development while AR artifact creation promoted TPK as well as integrative TPACK.
Lee (2015)	Helping college students improving critical thinking by using CSCL script based on questioning, reading, answering, and check strategy (QRAC)	Resources were used as a critical element of CSCL script. In the Q stage, article headings were provided, and in the R stage, whole articles were given to the learners. Individual learning through resources offered a foundation for collaborative learning in the R and C stage.
Zheng, Niiya, & Warschauer (2015)	A design-based study for designing wiki-based collaborative learning environment in a college	Students read resources provided and discussed based on their reading before completing wiki pages during the first and the fourth iteration, and students were provided previous students' work as exemplary work during the third iteration.

As indicated in Table 2-12, mobile media resources can help learners improve their content knowledge (Ke & Hsu, 2015), and reading resources can provide a base for learners' collaborative learning (Lee, 2015; Zheng et al., 2015). Therefore, resources can be an important element of CSCL scripts and offer supports for collaborative learning in CSCL. In the next section, I discuss popular-culture resources as a type of resource to support digital literacy development in CSCL.

Popular Culture as a Mediating Resource

Popular-culture resources, such as movies, animations, and pop songs, are effective resources for bridging gaps between school subjects and students' experiences in their everyday lives (Alvermann, 2012). However, it is difficult to find research studies in which popular-culture resources were used in digital literacy courses. Popular-culture resources can also offer learners meaningfulness and feelings of community, which are necessary for successful collaboration. Success in learning and collaboration in CSCL environments depends on several factors. For successful learning and collaboration, learners need to find social interactions meaningful (Goodyear et al., 2014). In addition, learners need to have a feeling of belongingness because belongingness facilitates the social interaction processes of exchanging information and providing help (Weinberger et al., 2009). Popular culture can provide common ground for learners so that they can engage in meaningful collaborative knowledge construction and collaborative projects.

Popular culture is comprised of what a group of people experience in common in their everyday lives (Alvermann, 2012). Movies, food, games, TV shows, clothing, blogging, social media, and general lifestyle are examples of popular culture (Alvermann, 2012). Bringing learners' popular culture into a school curriculum is a useful strategy to obtain learners' attention and motivate them to participate in classroom activities. Their attention is what educators need from students in modern classrooms, where information is abundant (Alvermann, 2012). Embedding popular culture in class activities can also help learners meaningfully engage in learning activities because popular culture is shared by learners (Lawrence, McNeal, & Yildiz, 2009; Pryor, 2008). Incorporating popular culture into learning activities helps learners anchor subject content to their existing knowledge structure.

Popular culture, such as movies, short stories, and pop songs, are widely shared by learners. In addition, popular cultural practices or topics such as creating commercial videos, publishing journal articles on blogs, watching football, and drawing comic strips can offer learners the feeling of community because the topics are related to learners' everyday lives. In this research, I investigate how bringing popular culture into learning activities can support learners' collaborative learning activities to improve digital literacies. With regard to this research question of exploring the relationship between popular-culture resources and digital literacies, the following is a review of the literature associated with the topic.

Popular culture and digital literacies. The necessity of popular culture in a curriculum are explained in several ways: (a) popular culture allows consumers to decode the meanings of popular cultural content differently; (b) the meaning of text is extended to include multimodal media such as audio, videos, images, and gestures; (c) the interactive nature of Web 2.0 technology brings learners to the places where play space and learning space are being blurred; (d) learners are so engaged in creating, editing, and sharing readily accessible multimodal digital content such as digital photos and videos (Alvermann, 2012). The engaging features of popular culture enable learners to raise their awareness of digital literacies as a social practice and join a participatory culture in which they develop their identities in digital literacy practices (Alvermann, 2012).

Recognizing the intersections of popular culture and literacy practices (Alvermann, 2011), researchers have tried to bring popular culture into teacher education and K-12 classrooms. For example, DeCoursey's (2012) research is one of the rare examples that investigates English language teachers' attitudes towards making animations. DeCoursey (2012) investigated teachers' views by analyzing teachers' written responses in surveys. The author also investigated difficulty, enjoyment, and opinions regarding the reception of animation by secondary learners and teachers. The results showed that teachers positively evaluated animation.

75.58% of teachers were strongly positive towards animation. They also felt that animation would be implementable in English language teaching.

Contrary to using popular culture in teachers' professional development, there is relatively abundant research using popular cultures in K-12 education. However, research on connecting popular culture to teaching on how to use media and technologies remains rare. Lawrence et al.'s (2009) study is a rare example of associating popular culture with technology education. Lawrence et al. (2009) incorporated popular culture such as graphic novels and comics into a summer program in which twelve high-school students learned various subjects such as math, technology, reading, and writing. Popular culture in Lawrence et al.'s (2009) research is being used to connect students' informal learning experiences to formal learning. The authors' research is an exemplary instance of combining popular culture and technology with literacy programs. In Lawrence et al.'s (2009) study, popular culture was used to grab students' attention and make learning relevant to students.

Popular culture is often adopted in K-12 education for literacy education to gain the attention of learners and develop literacies in the intersections of popular culture and digital literacies. However, it is rare to find research studies about educators' digital literacy programs where popular culture is incorporated. In the next section, I discuss why popular culture is disprivileged in digital literacy programs for educators.

Disprivileged popular culture in digital literacy education. I searched ERIC, ProQuest, and PsycINFO for literature regarding the role of popular culture and students in technology integration courses enrolled in digital literacy or technology integration courses. However, there is little research on the topic. Lack of research regarding the role of popular culture can be explained in several ways. First, teaching with popular culture is not an established practice in traditional classrooms. School practices are regulated by established patterns enforced or accepted by authorities (Merchant, 2012). Therefore, it is disruptive to established curricula to bring learners' popular culture into literacy classes and other subjects.

Second, some researchers and teachers find popular culture inappropriate for education. For example, popular culture is often disregarded by some teachers or school administrators because of the perception that popular culture belongs to the category of low culture, which is inappropriate for school subjects (Alvermann & Xu, 2003; Hagood, Alvermann, & Hruby, 2010; Shegar & Weninger, 2010). In addition, discussions on popular culture raise concerns regarding violent content and abusive messages (Pryor, 2008; Shegar & Weninger, 2010). Therefore, embedding popular culture in regular curricula is considered inappropriate by some researchers and teachers.

Finally, the field of education technology pays little enough attention to cultures (Asino, 2016). The field of educational technology does not focus much on how cultures impact learning and how instructional designers can create culturally appropriate designs (Asino, 2016). As the literature search results indicate, it is difficult to find technology integration research addressing popular culture in the field of educational technology, meaning that research on digital literacy courses often does not find the importance or relevance of connecting popular culture with technology integration. This suggests that many researchers and instructors in digital literacy courses are failing to see the intersection of popular culture and digital literacy practices, such as creating cartoons, publishing blogs, establishing digital citizenship in social media, and sharing animations through YouTube.

Excluding learners' popular culture in literacy education or technology courses builds walls between the dominant culture in formal curricula and students' out-of-school cultures.

Supporting only dominant cultures in school contexts and academia may result in learners concluding that what they learn in school or college is not connected to their real lives. Many learners use the Web in their informal learning environments to obtain multimodal information, and using multiple literacies is becoming an everyday practice for learners because the advancement of technology has brought images, audio, and videos to students' fingertips through various mobile devices.

Accordingly, social media platforms such as Instagram, Twitter, and Facebook encourage users to combine traditional texts with multimedia such as images, audio, and videos. The abundant combination of traditional texts and multimedia in learners' out-of-school literacy practices raises the necessity of incorporating popular culture into traditional or new literacies practices (Alvermann, 2011; Shegar & Weninger, 2010). Embedding popular culture in school curricula or digital literacy courses can bridge the gaps between learners' informal and formal learning (Lawrence et al., 2009; Petrone, 2013; Zehr, 2014).

Popular culture can be used in digital literacy courses because there are intersections between popular culture and digital literacies (see Alvermann, 2011). This study is designed to improve digital literacy courses by using learners' interest in and shared knowledge of popular culture in CSCL. In the current study, popular culture has three roles: (1) gaining students' attention; (2) making topics more relevant to students' lives; and (3) facilitating the collaborative knowledge building process.

CHAPTER 3

METHODOLOGY

In this chapter, I begin by describing the pilot study, which guided the current study. Next, I explain what I aimed to explore in this study with two research questions. I also describe participants, research design, practical framework presenting a designed CSCL environment, data collection, and analysis methods. Finally, I conclude by presenting the limitations of this study.

Pilot Study

I conducted a pilot study during Fall 2017 in order to establish design guidelines for students' digital literacy development in technology integration courses as well as to obtain initial ideas about what students' experiences were in the course activities. The pilot study was conducted to address the problems in digital literacy courses for students in technology integration courses. I investigated the following research questions for the pilot study:

1. How does students' digital literacy in technology integration courses develop during the course?

2. What are the students' experiences with collaborative activities?

3. What are the students' experiences with popular culture embedded in the course?

Through the pilot study conducted in the Fall of 2017, I identified digital literacy practice domains for students in technology integration courses and built guidelines for facilitating students' digital development in technology integration courses with collaboration guides and popular-culture resources. The results and findings from quantitative and qualitative data indicated participants' growth in digital literacies and satisfaction with the final products (see Appendix A, B, C, D, E for the results and findings, surveys, interview questions, and an example of collaboration guides). Regarding participants' experiences with popular culture, there was no statistically significant effect, but participants' already possessed highly positive perceptions regarding popular culture on the pre-survey, which ranged from 4.13 to 4.38 on a 5-point Likert scale, anchored between "Strongly disagree" and "Strongly agree."

In the next section, I describe how the pilot study guided the current study.

Changes Made to the Current Study Based on the Pilot Study

The pilot study was intended as the first iteration of a design-based research approach to address problems in technology integration courses. Overall, the collaborative activities which had collaboration guides worked well in the pilot study. However, the collaboration activity that did not have collaboration guides resulted in cooperation rather than collaboration. Furthermore, the results of the pilot study from the survey and interviews showed participant students were positive to popular cultural content in the activity. As a result of the pilot study, I generated the following design guidelines (Table 3-1) for technology integration courses.

Table 3-1

Design Guidelines and Strategies for Technology Integration Courses

Principles	Strategies
Build learning communities	● Provide opportunities for the learner to know each other better through icebreaking activities. ● Form groups dynamically by employing various group formation methods. ● Establish participatory culture for collaborative knowledge building and group projects.
Provide proper collaborative scripts to enhance collaborative interaction	● Identify learners' digital literacy competency through surveys and observations. ● According to learners' collaboration experiences with using technologies, provide collaboration scripts to enhance collaborative interactions. ● Provide collaboration scripts in both written and spoken forms.
Specify digital literacy practice domains for students in technology integration courses	● Provide learners with explanations of each digital literacy practice domain for students in technology integration courses. ● Offer learners the opportunities to co-construct knowledge regarding each digital literacy practice domain.
Embed popular culture to grab learners' attention and facilitate collaborative interactions	● Grab learners' attention to each digital literacy practice domain through popular culture such as movies, pop songs, and short stories. ● Connect popular culture, such as movies, music, and short stories, to each digital literacy practice domain to provide common grounds for collaborative knowledge building. ● Suggest popular cultural topics for group projects such as wiki page creation and MOOC creation.
Model media and technology integration and popular culture embedment	● Model media and technology integration regarding each digital literacy practice domain through teaching activities. ● Offer practical examples of media and technology integration situated in K-12 schools.

Based on the design guidelines in Table 3-1, the collaborative activities for investigation have been changed. In the pilot study, five collaborative activities were investigated, but in the current study, an approximately five-week long project of creating a collaborative Web site was investigated after a major design change. The project in the current study was mainly about students' co-construction of knowledge regarding digital literacy practice domains. Accordingly, the research questions, which I specify in the following section, were also changed.

In the pilot study, I found that some participants did not engage in collaboration but in cooperation in the collaborative knowledge building activities. Furthermore, supporting students' collaborative activity in technology integration courses was indirect in the other activities rather than a collaborative knowledge building of digital literacy practice domains. Therefore, in the current study, as Table 3-2 shows, I designed a project in which students create and design a collaborative Web site regarding six digital literacy practices, and students' collaboration is guided by collaboration guides in the form of CSCL scripts based on the design guidelines and strategies for students' digital literacy development in technology integration courses.

Table 3-2

Changes from the Pilot Study

Pilot study activities	**Digital literacy practice**	**Changed Activities**	**Digital literacy practices**
Google My Maps	Social interaction	Creating and designing a collaborative Web site regarding six digital literacy practices	Social interaction, creating, publishing, digital citizenship, research, and problem solving
Video commercial	Creating		
Block programming	Problem solving		
Massive open online courses	Publishing		
Collaborative knowledge building of digital literacy practice domains	ISTE standard for students (2016)		

Second, as a result of changes to the focus project, I made relevant changes to the pre- and post-surveys (Appendix F and G) and the interview protocol (Appendix H) to make the survey questions more specific for the focus project. In addition, I removed the collaboration survey and popular-culture survey from the pre-survey because the modified survey questions about collaboration and popular culture can be answered based on participants' experiences with the course project.

Finally, the duration of the data collection was changed from the pilot study. While the pilot study data was collected over one semester, the data was collected in approximately 5 weeks because the current study focuses on a single project.

Purpose Statement and Research Questions

This study aimed to explore students' experiences in technology integration courses in a CSCL environment supported by collaboration guides and other multiple scaffolds: question prompts, resources, and popular-culture resources. Specifically, I was interested in investigating (a) students' digital literacies shown in the Technology Genius Project set in a CSCL environment and (b) students' experiences with multiple scaffolds. The following research questions were addressed in the context of an undergraduate course – "Introduction to Computers for Teachers."

1. How do the instructional scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—support collaborative activities during the Technology Genius Project?

2. What digital literacies are reflected in the Technology Genius Project developed in an undergraduate technology integration course?

The context of the study in which the research questions above were investigated was as follows.

Context

The context for this study was to support students' digital literacy development in an introductory technology integration course for students in technology integration courses in the College of Education of a large land-grant university in the southeastern USA. The courses were designed to improve students' knowledge and skills regarding technology integration into education in technology integration courses. The technology integration courses were so popular among students in the university that 10 courses under the same course name were taught in the spring semester of 2019. Although the course was primarily intended for students in technology integration courses, students from various backgrounds took the course to improve technological knowledge for their lives and education (Chien, 2015).

Students in the courses had the opportunity to practice technology integration into education and reflect on what meaningful integration of technology was. The students engaged in various collaborative activities and projects to improve their understanding of meaningful integration of technologies. However, there is little research on how to support students' collaborative activities in technology integration courses to enhance their digital literacies in CSCL. In addition, it is difficult to find research studies on making collaborative activities and projects more relevant to students in technology integration courses by embedding popular culture in digital literacy courses for students in technology integration courses.

In this study, I investigated how a digital literacy course unit for students in technology integration courses could be designed effectively by supporting collaborative activities and projects with multiple instructional scaffolds. The digital literacy course unit was called the Technology Genius Project (TGP), which was composed of ten phases. As shown in Table 3-3, The TGP has similarities with and differences from the Genius Hour and *learning by design* approach often associated with the TPACK framework. The TGP borrowed the word *genius* from the Genius Hour because, like the Genius Hour, it was designed to provide learners with opportunities to make an inquiry regarding certain topics. However, students in the TGP conducted research on the topics regarding digital literacy practices to build knowledge of and skills about digital literacy practices and the meaningful integration of technology into education with the support of multiple scaffolds. Like the *learning by design* approach, the TGP was a collaborative design project involving tasks with the authentic elements. However, the TGP focused on students' participation in digital literacy practices in social contexts rather than TPACK.

Table 3-3

Comparison of the TGP, Genius Hour, and Learning by Design

	The TGP	
	Similarities	**Differences**
The Genius Hour	• Learners make an inquiry about certain topics.	• In the TGP, learners are guided on what and how to do a collaborative inquiry and design project regarding one selected topic among several digital literacy practices. • In the Genius Hour, learners make an individual inquiry into his or her own topic of their own interests in their own ways (Juliani, 2014).
The *learning by design*	• Learners collaboratively design artifacts such as lesson plans in which technology is integrated.	• In the TGP, learners join the participatory culture (see Jenkins et al., 2015; Lotherington & Jenson, 2011) to implement their digital literacy practices by conducting research and creating, designing and publishing artifacts such as webpages, videos, and lesson plans. • In the *learning by design* approach, the focus is on improving TPACK but not on participating in digital literacy practices.

Throughout the TGP in the current study, students were required to engage in within- and between-group collaboration in order to create a collaborative Web site, which was composed of six pages regarding digital literacy practices. In addition, each page had three sections: an explanation about each group's digital literacy practice(s), a video commercial for their chosen tools, and a lesson plan. The students participated in the digital literacy practices of creating, designing, and publishing webpages, video commercials, and lesson plans to share their knowledge of and skills about digital literacies with other educators around the world. Therefore, the culminating product in the TGP was a Web site that students created together. Students' knowledge and skills about digital literacies shown in collaborative learning processes and final products were investigated through quantitative and qualitative data. In addition, how multiple scaffolds support collaboration processes was explored. In the next section, I describe the recruitment processes and research participants.

Participants

Participants were recruited from another instructor's (Antonio's) class (Class A, n = 20) and two of my classes (Classes B and C, n = 20 and n = 21, respectively). The technology integration course in this study was designed for pre-service teachers, but undergraduate students from diverse backgrounds also enrolled in the courses. Table 3-4 shows the diverse majors of sixty-one students in total from Classes A, B, and C who participated in this study.

Table 3-4

Participant Students' Majors

Majors	Number of participant students		
	Class A	Class B	Class C
Communication Sciences and Disorders	9	3	3
Speech Pathology	-	-	1
Early Childhood Education	-	5	-
Social Studies Education	-	1	-
Elementary Education	-	1	-
Philosophy	-	-	1
Psychology	-	-	1
Management Information Systems	1	-	1
Cognitive Science	-	-	1
Management	-	-	1
Economics	-	-	2
Business	1	1	-
Advertising	-	3	1
Finance	-	-	-
Accounting	2	-	-
Public Relations	-	1	-
International Affairs	-	-	1
Sports management	-	2	-
Exercise and Sports Science	1	-	-
Journalism	1	1	-
Broadcast Journalism	-	-	1
Criminal Justice	-	1	-
Film Studies	-	1	-
Cellular Biology	-	-	1
Micro Biology	-	-	1
Biology	1	-	2
Health Promotion	-	-	1
Public Health	1	-	-
Nursing	-	-	1
Animal Science	-	-	1
Pharmaceutical Sciences	1	-	-
Undecided	2	-	-
Total	20	20	21

Note. The gray colored majors are from the College of Education.

Although students from diverse backgrounds and grades took the courses, they were well aware that these technology courses were meant for students who wanted to integrate technologies into education because the course title and syllabus indicated that the courses were created for teachers who wanted to learn technologies for education.

Research Design

This study is best described as a mixed-methods study (Creswell, 2014), which focused on enhancing the opportunities that students in technology integration courses had to develop their own digital literacies so that they could later enhance the digital literacies of their own students when they are full-fledged teachers. The intervention that was investigated in this study was a computer-based collaborative learning environment through which students in technology integration courses engaged in learning processes that were designed to foster digital literacies. Because humans often learn by engaging in social interaction (Vygotsky, 1978), and learners can benefit from using media and technology for digital literacy practices in social contexts, I chose a CSCL environment for this study. In addition, I investigated participants' experiences in the CSCL environment that supported students' digital literacy development in technology integration courses with the multiple scaffolds.

I explored the research questions in natural classrooms. I chose a mixed-methods design because combining both quantitative and qualitative methods can reduce the limitations of each method (Creswell, 2014). In addition, a mixed-methods study is practical because researchers can investigate research questions more thoroughly through both qualitative and quantitative data (Creswell, 2014; Garland, 2013).

This research followed a convergent parallel mixed-methods design within the mixed-methods approach, in which qualitative and quantitative data is collected simultaneously (Creswell, 2014; Fetters, Curry, & Creswell, 2013). In this study, qualitative data and quantitative data was gathered "during a similar timeframe." (Fetters et al., 2013, p. 2137). For example, during the study, quantitative data was collected at the beginning and end of the study in Fall 2019, and qualitative data was collected throughout the study after the start of the TGP. This study also followed a "QUAL+quan" design within convergent mixed-methods design (Morse, 1991, p. 121), which means the study was primarily a qualitative study with quantitative data complementing the qualitative data (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Morse, 1991). The research results and findings were cross-validated through quantitative and qualitative results (Creswell, 2014). The quantitative data was analyzed separately from qualitative data. The findings of the study included the analysis of quantitative surveys, qualitative interviews, field notes of my observations, and research participants' products. I triangulated those separate data analyses to interpret the research results and findings.

Practical Framework

The practical framework focuses on designing a CSCL environment for facilitating students' digital literacy development in technology integration courses with collaboration guides and other multiple scaffolds. The design of the CSCL environment, the TGP, was based on the conceptual framework of digital literacies and collaborative learning, which was presented in an earlier chapter. The TGP in this study was designed to enhance students' knowledge of and skills in digital literacies in six elements of digital literacy practice domains (DLPDs) for students in technology integration courses in the process of creating a collaborative Web site. As mentioned earlier, the culminating product of the TGP was a Web site, which comprised six pages composed of three sections: the explanation, video commercial, and lesson plan section. The students' collaborative learning was facilitated by the multiple scaffolds.

The Overview of the TGP Design

The TGP was designed to help students engage in authentic digital literacy practices in which they share digital knowledge and skills regarding six digital literacy practices with educators around the world by creating and designing webpages. Therefore, the design focus of the TGP was to support learners' digital literacy practices with multiple scaffolds in a CSCL environment. Table 3-5 shows the overview of the TGP, which had three main tasks and ten phases. Among the ten phases, collaborative knowledge building activities took place from phase 2 to phase 9. In order to create the webpages, students needed to co-construct knowledge of each digital literacy practice domain (DLPD), create video commercial plans collaboratively, publish video commercials that introduced tools associated with each DLPD, and create lesson plans in which they demonstrated their knowledge of meaningful integration of technology. At the end of the TGP, students were supposed to evaluate other groups' products which were posted to each group's webpage using the evaluation rubric (see Appendix I). After finishing phase 10, each group of students created and published a webpage about a digital literacy practice domain(s).

Table 3-5

Overview of the Technology Genius Project

Items	Description	Focus
Objectives	Learners will gain the knowledge of digital literacy practices and develop skills in implementing digital literacies by joining online participatory culture and engaging in collaborative knowledge building activities under the support of peers, instructors, and computers.	Participatory digital literacy practices of designing and publishing webpages, video commercials, and lesson plans; interacting with each other; establishing digital citizenship; and conducting research with the goal of sharing collaborative knowledge regarding digital literacy practices
Tasks	● Learners conduct research on digital literacy practices to construct knowledge of digital literacy practice together with the support of computers, peers, and instructors. ● Learners create, design, and publish video commercials together about their chosen technological tools to show their understanding of technologies. ● Learners create lesson plans together in which they integrate technologies meaningfully. ● Learners design and publish a Web site together about digital literacy practices.	Individual and collaborative knowledge and skill building about digital literacy practices
Assignments	Learners complete six assignments about building individual knowledge of digital literacy practices	Individual knowledge building about digital literacy practices
Model lesson activities	Learners engage in model lesson activities called Tech force/Model lesson which demonstrate each digital practice.	Focus on digital literacy knowledge and skills
Phases	Phase 1 – Learn to create and publish Web sites	Focus on skills
	Phase 2 to Phase 9 – Build collaborative knowledge of each digital literacy practice domain ● What are communicating/collaborating /creating/publishing/interacting/researching/ establishing responsible digital citizenship/solving problems? ● What are the tools and Web sites for communicating/collaborating/creating/publishing/interacting/researching/establishing	-Focus on collaborative knowledge building/improving digital literacy skills/attitudes -Focus on participatory culture: YouTube and webpages

	responsible digital citizenship/solving problems? ● Design, create, and publish video commercials for their chosen tools ● Design and publish lesson plans to help K-12 students engage meaningfully in digital literacy practices. ● Design webpages and publish them.	
	Phase 10 – Present the completed webpages to classmates and review other groups' work.	Focus on collaborative knowledge building/improving digital literacy attitudes
Assessment	Peer assessment about webpage content, video commercials for their chosen tools, and lesson plans.	Focus on design and meaningful use of media and technologies

Note. Collaborative knowledge building activities take place in bolded lessons.

The TGP was designed to produce six pages according to digital literacy practices. Regarding social interaction digital literacy practice, students were supposed to create two webpages—communication and collaboration webpages—because there are relatively diverse tools available for communication and collaboration, although communication and collaboration can often occur at the same time in education. Creating and publishing digital literacy practices were combined into one webpage because creating and publishing tools are not as diverse as tools for social interaction, and publishing often occurs after creating is completed. As a result, even though social interaction digital literacy practices were divided into two sections, there were still six pages in total on the final Web site. Following this class Web site plan of six webpages, students were expected to belong to one of the groups shown in Table 3-6.

Table 3-6

Grouping Plan of the TGP

Group No.	Digital Literacy Practice(s)
1	Social interaction (communication)
2	Social interaction (collaboration)
3	Creating and publishing
4	Digital citizenship
5	Research
6	Problem solving

In addition, Figure 3-1 shows the context, goal, and overview of the TGP design which was designed to help each individual closely collaborate with within- and between-group members. Students were expected to engage in individual knowledge building through assignments accompanying each phase and collaborative knowledge building from phase 2 and phase 9. Across lessons, students were supposed to give feedback on other groups' work. Based on the feedback, each group updated their group work and finally created their webpages on the class Web site.

The Context and Goal of the TGP Some teachers are asking you about what digital literacies are. Your task is creating a Web site about digital literacies for educators with your classmates to share knowledge of digital literacies.
*IKB= Individual knowledge building / CKB = Collaborative knowledge building

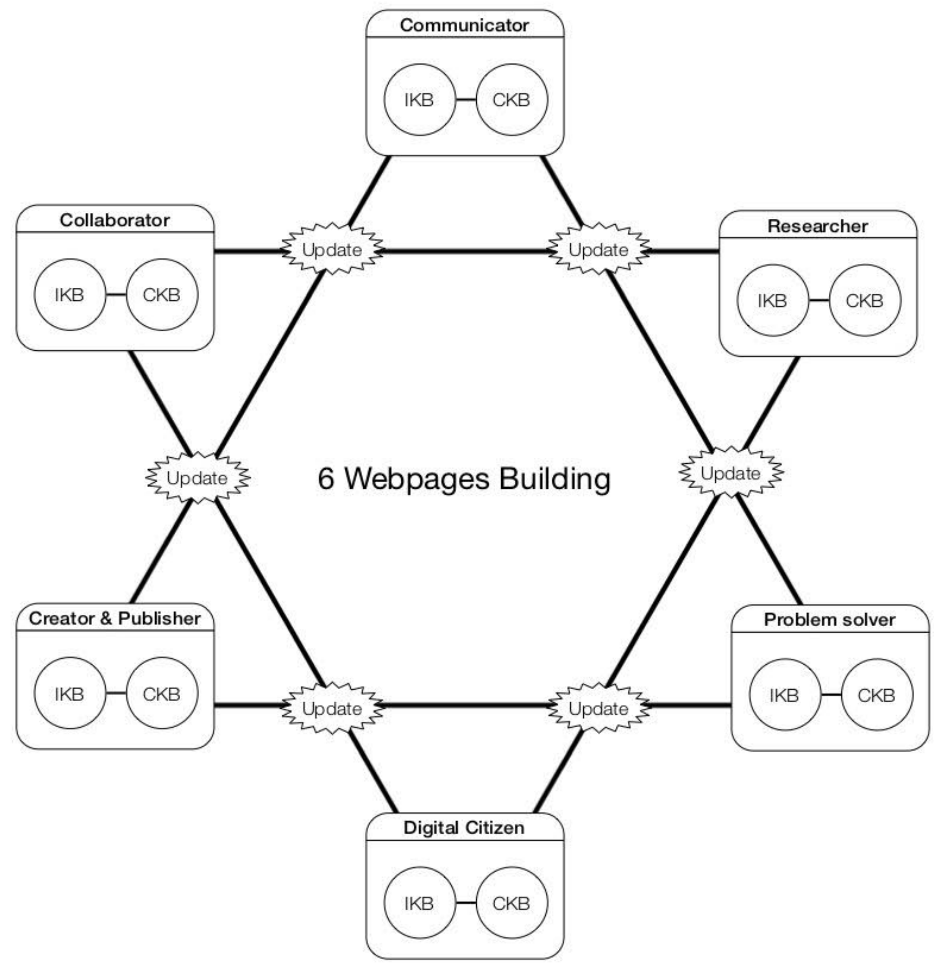


Figure 3-1. The overview of the collaborative knowledge building and webpages design

The collaborative learning shown in Figure 3-1 was supported by multiple scaffolds. In the next section, I describe the design of the collaboration guides first.

The Design of Collaboration Guides

Collaboration guides in the form of CSCL scripts were designed to guide and support students' collaborative learning activities. First, according to CSCL script specification

Dillenbourg (2002), phases were set as shown in Table 3-7. In phase 1, individual students learned how to create a Web site using the new Google Sites platform. In phase 2, each group worked on creating the initial document of its digital literacy practice(s). This initial document was circulated, and other students gave feedback on the circulated documents starting with phase 3 until the end of phase 7. To circulate the initial document virtually, each group had its own number. To determine the group to receive feedback, the group providing feedback added +1, +2, +3, +4, or +5, depending on the week, to its own group number. Based on the feedback, the owner group of the initial document updated their document. In phase 8, each group designed, created, and published video commercials for their chosen tools. In phase 9, each group came back to their own initial document to design, create, and publish a collaborative webpage on the class Web site. In phase 10, which was the final stage, each group presented their final products—the explanation of its digital literacy practice(s), video commercials for its chosen tool, and lesson plan—to their classmates.

Table 3-7

Phases of the Collaboration Guides

*Phase 1 = Individual practice about creating Web site / Phase 8 = Creating video commercials / Phase 10 = Presentation
*IKB= Individual knowledge building / CKB = Collaborative knowledge building
*section 1 = Explanation of groups' digital literacy practice(s)
*section 2 = Designing video commercials for groups' chosen tool
*section 3 = Designing Lesson plan

	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 9
Each group's task	IKB 1 (com.)	IKB 2 (col.)	IKB 3 (creator & publisher)	IKB 4 (digital citizenship)	IKB 5 (res.)	IKB 5 (problem Solving)	A webpage designing and publishing regarding each group's digital literacy practice(s)
	CKB regarding each group's digital literacy practice(s) (Focus on section 1)	Giving feedback on Group +1 & +2's entire work	CKB regarding each group's digital literacy practice(s) (Focus on section 2)	Giving feedback on Group +3 & +4's entire work	CKB regarding each group's digital literacy practice(s) (Focus on section 3)	Giving feedback on Group +5's entire work	
		Update	Update	Update	Update	Update	

After the phases were created, group formation methods, tasks, modes of collaboration, and timing were specified. Systematic or student-led spontaneous group formation (Borges, Mizoguchi, Bittencourt, & Isotani, 2018) was considered. At the implementation of the TGP, spontaneous group formation was chosen to respect students' autonomy, and as a result, students worked together with the group they selected for the duration of the TGP.

Each task, collaboration mode, and timing of activities was guided through the TGP webpages as shown in Figure 3-2. These elements of collaboration guides were provided in association with other resource pages which include question prompts, digital literacy resources, and popular-culture resources.

Tasks, collaboration modes, and timing specification of the TGP
Today's Task: 1. Go to the Google document and give feedback to the +5 group's **whole** document (10-15 min). 2. Go to your group's section on the Google document and update the **whole** document reflecting the feedback (30-35 min).
Other resources associated with collaboration guides
Technology Genius Project 7 (Monday, 10/1) **Logistics:** • This is the website which the whole class create together (If you login with your Gmail, you can edit this site) • This is the model / guidance website you can refer to • This is the Google Document you collaborate to create the class website (If you login with your Gmail, you can edit this site). • These are resource pages (communication / collaboration / creating & publishing / digital citizenship / research / problem solving) • This is the rubric for TGP

Figure 3-2. Example of a task, collaboration mode, and timing at a TGP webpage in association with the guidance regarding resource pages

In addition to collaboration guides, other scaffolds were provided to support students' collaborative work through the resource pages (see Figure 3-2), which are described in the following section.

Supporting Collaborative Learning with Multiple Scaffolds

In addition to the collaboration guides, other scaffolds—question prompts, digital literacy resources, and popular-culture resources—were provided for students' collaborative learning. Their provision was interconnected with each other. That is to say, some question prompts referred to digital literacy resources and popular-culture resources as shown in Table 3-8, which displays question prompts for the social interaction digital literacy practice, as an example. Question prompts for individual knowledge building were created to build students' knowledge base regarding each digital literacy practice domain, diverse technologies, and technology integration into education in association with digital literacy resources and popular-culture resources. Each individual's knowledge base was expected to contribute to collaborative knowledge building. In addition, the collaborative knowledge building activities, which were also supported by question prompts, culminated in the form of webpages regarding six digital literacy practice domains.

Table 3-8

Examples of Question Prompts for Social Interaction Digital Literacy Practice

*IKB= Individual knowledge building / CKB = Collaborative knowledge building

Area	Question prompts for IKB	Question prompts for CKB
Social Interaction (Communicator)	● What is communication? ● Read the webpage provided and watch movie clips from *Arrival* and answer the following question. ● What makes communication difficult? ● View the tools provided. What are your favorite communication tools? ● What kinds of communication activities can you do with your favorite tools if you teach K-12 students?	● What is the question your group wants to investigate about the digital literacy practice of communication? Please answer your group's question. ● What is communication using technology? ● What are communication processes? ● What makes communication difficult? ● How can teachers communicate with students and parents effectively using technologies? ● What are tools for communication? ● What are your favorite communication tools? And why?
Social interaction (Collaborator)	● What is collaboration? ● Read the webpage provided and watch movie clips from *Avengers* and *Flash* and answer the following question. ● Why or why do you not think that students can benefit from collaboration? ● View the tools provided. What are your favorite collaboration tools? ● What kinds of collaboration activities can you do with your favorite tools if you teach K-12 students?	● What is the question your group wants to investigate about the digital literacy practice of collaboration? Please answer your group's question. ● What is collaboration? ● What is the difference between collaboration and cooperation? ● How do theories support collaboration? [e.g., Vygotsky] ● What makes collaboration important? ● What are the digital tools for collaboration? ● What are your favorite collaboration tools? and why?

Digital literacy resources and popular-culture resources were provided through separate webpages in association with question prompts. Each digital literacy resource page was mainly composed of three sections: explanation about corresponding digital literacy practice, technologies related to the digital literacy practice, and exemplary teaching and learning activities for it. In addition, as Table 3-9 shows, popular-culture resources, represented in the form of movies, dramas, YouTube videos, and pop songs, were used to play a facilitating role in students' collaborative learning. Each popular-culture resource was associated with an individual knowledge building assignment.

Table 3-9

Popular-Culture Resources and IKB

* IKB=individual knowledge building

Digital Literacy Practices	**Popular-culture resources**	**IKB tied to the resources**
Social Interaction (Communication)	Movie clips (*Arrival*)	IKB 1
Social Interaction (Collaboration)	Movie clips (*Avengers: Infinity War*, *The Wizard of Oz*) and drama clips (*The Flash*)	IKB 2
Creator & Publisher	Movie clips (*Ready Player One*) and drama clips (*Westworld*)	IKB 3
Digital Citizen	Drama clips (*Black Mirror*, Season 3, Episode 1, "Nosedive")	IKB 4
Researcher	Pop songs (Class Idea and Another Brick in the Wall) and a TED talk, School in the Cloud	IKB 5
Problem Solver	Movie clips (*The Imitation Game*)	IKB 6

In addition to the multiple scaffolds, tools were provided to support students' collaborative learning, as shown in the following section.

Digital Literacy Practices and Supporting Tools

The TGP was designed to help students improve their digital literacy knowledge and skills by engaging in meaningful digital literacy practices rather than learning specific popular tools. Therefore, digital literacy practices were identified first and supporting tools were chosen afterward by me or the students themselves. Some key features of Google Docs, new Google Sites, and YouTube—the comment features of Google Docs, page creation and publishing of new Google Sites, and YouTube channel creation and publishing—were introduced and practiced because they were considered as core skills for the TGP. However, students were allowed to choose other video publishing platforms in addition to YouTube. Table 3-10 shows six digital literacy practices and supporting tools in the TGP.

Table 3-10

Digital Literacy Practices and Supporting Tool Examples

Digital Literacy Practices	Supporting Tools	Practice examples in the TGP
Social Interaction	Google Docs, **Group chatting Tools**	Communicating and collaborating on Google Docs using the comment feature
Creating	**iMovie, Cell phones, Voice recording tools, Screen recording tools, Videostar, Photobooth,** Google Docs	Creating video commercials and web content
Publishing	**YouTube, Vimeo,** Google Sites	Sharing video commercials and digital literacy knowledge
Digital Citizenship	Google Sites, **YouTube**	Establishing adequate digital citizenship with educator identities
Research	**Google**	Conducting research on digital literacy practices and tools
Problem Solving	Google Sites, Google Docs, **iMovie**	Designing webpages and video commercials to communicate information about digital literacy practices and tools effectively to other educators

Note. Tools chosen by students are in bold

As shown in Table 3-10, the TGP was not focused on teaching or learning specific tools but on students' participation in digital literacy practices through a design project in which students conduct research on digital literacy practices collaboratively and share their knowledge with people around the world using their digital literacy skills. Therefore, students in the TGP had the opportunities to explore diverse tools available and use their favorite tools to complete the project. In the next section, I present the timeline for the study.

Timeline for the Study

Table 3-11 provides an overview of the study timeline. I recruited research participants in the first week of September 2018. I asked the research participants to complete a pre-survey during the recruitment. The pre-survey was composed of questions regarding demographic information, digital literacy understanding/skills, pedagogical digital literacies, and attitudes about teaching digital literacy practices to K-12 students.

Table 3-11

Timeline for the Study

Timeline	Task	Data
4^{th} - 5^{th} week of August	Recruitment and pre-survey	Recruitment and pre-survey
2^{nd} week of September to 2^{nd} week of October	Intervention (The Technology Genius Project)	Field notes of my observations and participant products
2^{nd} week of October to 1^{st} week of November	Post-survey and group interviews	Post-survey and interviews
November to December	Analysis of quantitative results and qualitative findings, such as field notes of my observations, group interviews, participant product analysis	
From January	Describe results, findings, and conclusions	

The research participants engaged in the TGP from the 2nd week of September to the 2nd week of October, for a total of 5 weeks. I created field notes as a participant observer in two courses I taught and as a non-participant observer in one course that another instructor (Antonio) taught. At the end of the TGP, the research participants were asked to complete a post-survey. Group interviews were conducted after the TGP. I invited two groups from Class A, which showed different aspects of collaboration; one group was very active and lively during the TGP, and the other group was very calm and focused. The aspects of each group collaboration from Classes B and C were not varied much; therefore, I chose to invite two groups from Class B and three groups from Class C whose group members volunteered to be interviewed the most from each class. I conducted interviews to explore their experiences in digital literacy development, collaboration processes, and multiple scaffolds. In November and December, I analyzed both quantitative results and qualitative findings.

Data Collection Methods

As explained in the research design section, this research study used a mixed-methods design. Table 3-12 shows connections between research questions and data collection methods. Surveys, interviews, field notes, and documents, such as participant products and archival data, were closely associated with the two research questions about digital literacy development and the supporting role of multiple scaffolds.

Table 3-12

Association between Research Questions and Data Collection Methods

Research Questions	Surveys	Interviews	Observations	Products	Archival data
1. How do the instructional scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—support collaborative activities during the Technology Genius Project?	√	√	√	√	√
2. What digital literacies are reflected in the technology genius project developed in an undergraduate technology integration course?	√	√	√	√	√

Table 3-13 shows five different types of data that I collected to provide a basis for addressing the research questions. In the next sections, I describe each data type more in detail.

Table 3-13

Data Collection Methods

Data	Content	Data analysis strategy
Pre-survey	Questionnaire regarding digital literacies	Paired sample *t*-test, Wilcoxon Signed-Rank test
Post-survey	Questionnaire regarding digital literacies, collaboration, and multiple scaffolds: collaboration guides, question prompts, digital literacy resources, and popular-culture resources	Paired sample *t*-test, Wilcoxon Signed-Rank test, Descriptive statistics
Interviews	Interviews regarding research participants' project experiences	Thematic analysis
Observation	Instructor's reflections and observation notes about projects	Thematic analysis
Participant products	Products of collaborative knowledge construction, individual activities, and class project artifacts	Thematic analysis
Archival data	Course content such as popular-culture resources and other teaching and learning materials	Thematic analysis

Questionnaires

Pre- and post-surveys investigated the extent of research participants' digital literacy development and the changes in their attitudes regarding teaching digital literacies to K-12 students. In addition, post-survey explored research participants' perceptions about collaborative activities and scaffolds in the TGP. As Table 3-14 shows, the pre-survey had one section titled digital literacies, and the post-survey was composed of two sections: 1) digital literacies and 2) collaboration and scaffolds. Demographic questions were added to the pre-survey. As shown in Table 3-14, I used both closed-ended and open-ended questions (see Zohrabi, 2013) to investigate research participants' digital literacies and attitudes about digital literacy. Research participants were allowed to add comments after their answers to closed-ended questions regarding collaboration and multiple scaffolds.

Table 3-14

Components and Foundations of Survey Questions

Survey	Scale	Factors	NO. of items	Foundations
Pre-and post-survey	Digital literacies	- Knowledge - Technological skills about social interaction - Pedagogical confidence/Attitudes	2 2 2/2	Ferrari (2012); Ferrari (2013); Instefjord and Munthe (2016); ISTE (2016); ISTE (2017); Reynolds (2016); Tondeur et al. (2017)
		- Knowledge - Technological skills about creating - Pedagogical confidence/Attitudes	1 1 1/1	
		- Knowledge - Technological skills about publishing - Pedagogical confidence/Attitudes	1 1 1/1	
		- Knowledge - Technological skills about digital citizenship - Pedagogical confidence/Attitudes	1 1 1/1	
		- Knowledge - Technological skills about problem solving - Pedagogical confidence/Attitudes	2 2 2/1	
		- Knowledge - Technological skills about research - Pedagogical confidence/Attitudes	1 1 1/1	
		- Subjective attitudes about digital literacy	**2**	
Post-survey	Perceptions about collaboration	- Learning - Interaction - Process - Product	*6* *1* *1* *1*	Fischer et al. (2013); Wang and Mu (2017)
	Perceptions about scaffolds	- Collaboration guides - Popular-culture resources - Question prompts - Digital literacy resources - Tech force/Model lesson	*1* *1* *1* *1* *1*	Alvermann (2012); Hazari and Thompson (2015)

Note. Bolded are open-ended questions and italicized are closed-ended questions in which survey participants can add comments to their answers.

To raise the validity of questionnaires, I based survey questions regarding digital literacies on each digital literacy domain, which was identified by analyzing established digital literacy frameworks and standards such as the contemporary learning practices framework (Reynolds, 2016), ISTE standards for students (ISTE, 2016) and teachers (ISTE, 2017), and DIGCOMP (Ferrari, 2013). Regarding the collaboration open-ended questionnaire, I adapted the factors about collaboration perceptions from Hazari and Thompson's (2015) measurement tool.

Interviews

Through semi-structured interviews (Roulston, 2010), I investigated research participants' experiences in the TGP regarding digital literacies and multiple scaffolds. In semi-structured interviews, interview protocol guided interview processes and follow-up questions are allowed in accordance with interviewees' responses (Roulston, 2010). As mentioned earlier, I invited the group interview participants based on their groups' collaborative aspect during class activities (Class A: 2 groups) and their voluntary participation (Class B: 2 groups / Class C: 3 groups), as shown in Table 3-15.

Table 3-15

Group Interview Participants

Classes	**Group**	**Participants (pseudonyms)**
Class A	Group A-1	Amelia and Emma
	Group A-2	Amanda, Andrea, Baker, and Mark
Class B	Group B-1	James and Nadin
	Group B-2	Anne, Bella, Jane, and Sophia
Class C	Group C-1	Chelsea, Chris, Jasmine, and Rachel
	Group C-2	Evan, Gina, and Odin
	Group C-3	Ava, Luke, and Megan

As shown in Table 3-16, I anchored each interview question to the research questions to increase reliability of the interview protocol (Castillo-Montoya, 2016). I created the interview protocol following Carspecken and Fran's (1996) recommendations. I initiated interviews with "lead-off" questions regarding digital literacies, collaboration, and popular culture (Carspecken & Fran, 1996, p. 157). The "follow-up questions" (Carspecken & Fran, 1996, p. 157) are created based on a literature review (Jacob & Furgerson, 2012). The "covert-categories" shown in the interview protocols were the items that I wanted to hear about during interviews although I would not ask through direct questions because asking them requires too much time (Carspecken & Fran, 1996, p. 157).

Table 3-16

Lead-off Questions and the Focus of Each Question

Lead-off Interview questions	Research Questions	Foundations
● Tell me about your overall experiences in the Technology Genius Project. ● What knowledge did you learn through the Technology Genius Project? ● What skills did you learn through the Technology Genius Project? ● Tell me about your experiences in creating lesson plans during the Technology Genius Project.	Q2– Digital Literacies	Ferrari (2012); Gee (2015); Instefjord and Munthe (2016); Reynolds (2016)
● Tell me about your overall experiences with collaboration during the Technology Genius Project. ● Tell me about how your group interacted with each other for the project. ● Tell me about your experiences in giving feedback to other groups' work / receiving feedback from other students. ● Tell me about your experiences in collaboration guides provided by the instructor. ● Tell me about your experiences in question prompts provided by the instructor. ● Tell me about your experiences in resources provided by the instructor.	Q1 – Collaboration /Scaffolds	Dillenbourg (2002); Fischer et al. (2013); Hazari and Thompson (2015); Wang and Mu (2017)
● Tell me about your overall experiences in popular-culture resources in the Technology Genius Project. ● What did you learn from popular culture? ● How did popular culture influence collaboration processes?	Q1– Popular culture	Alvermann (2011); Alvermann (2012); Hagood et al. (2010);

There was a concern about the reliability of interview findings for the interviews with those students I taught because I was conducting research as their course instructor. The research participants would likely refrain from saying negative comments towards course activities.

However, I expected that my notification about the importance of students' honest responses to interview questions would increase reliability of the interview findings.

Another issue was related to the interview analysis. Since I analyzed the interviews alone, it can raise a reliability issue. To offset reliability issues of interview findings, a code checker confirmed the analysis. In addition, I triangulated other research findings from different data sources (Roulston, 2010). In the following section, I describe observation notes and participants' products as other qualitative data sources.

Observation Notes and Documents

Class participant observer notes (Spradley, 2016), non-participant observer notes (Spradley, 2016), and documents (Prior, 2003) such as participants' products and archival resources provided different sources of information for informing the overall research findings in this study. I created participant observer field notes (see observation protocol attached in Appendix J) in courses I taught as a course instructor, and non-participant observer field notes by observing a class taught by another instructor. Regarding my approach to the observation, I followed some of the procedures suggested by Emerson, Fretz, and Shaw (2011): taking note of initial impressions, focusing on what is significant or unexpected, attending explicitly to what those in the setting experience and react to, and focusing on how actions in the setting are organized and take place. In Antonio's class, I took observation notes during the class session itself. In my classes, I made observation notes during class when possible, expanding my observation notes as soon as each session ended.

According to Prior (2003, p.2), documents include "paintings, tapestries, monuments, diaries, shopping lists, stage plays, adverts, rail tickets, film, photographs, videos, engineering drawings, the content of human tissue archives and World Wide Web (WWW) pages. In this study, documents included participants' individual and collaborative products such as Google Docs activities and feedback, video commercials created by students, lesson plans, and webpages created by students. In addition, archival data collected in this study referred to course content created for teaching and learning activities. Based on Prior (2003), I analyzed producers, consumers, actions, words, phrases, content, patterns, and themes found in the documents. In the next section, I describe how I analyzed the data.

Data Analysis

As mentioned earlier, I collected and analyzed quantitative data such as research participants' responses to the pre- and post-surveys and qualitative data such as interviews, field notes, participants' products, and archival data.

Quantitative Data Analysis

Regarding digital literacy pre- and post-surveys, I investigated the effect of the TGP by analyzing research participants' responses to pre- and post-surveys. The Wilcoxon Signed-Rank test was conducted to investigate the mean differences between pre- and post-surveys in Class A ($n = 20$) because of the small sample size (Russell, 2018). Regarding the analysis of pre- and post-surveys in classes A and B ($n = 41$ in total), I performed a paired sample *t*-test to explore the mean differences between the surveys after the normality test (Moore, McCabe, & Craig, 2014). In addition, research participants' perceptions regarding collaboration and multiple scaffolds were investigated through descriptive statistics, which described frequency, means, and standard deviations.

Qualitative Data Analysis

To analyze the qualitative data, I followed a thematic data analysis method (Braun & Clarke, 2006). I also followed Merriam's (2009) suggestions to analyze the documents, field notes, and interviews. I followed the following analytical procedure according to the Merriam's (2009) suggestions:

- I imported separate files containing documents, field notes, and transcripts into the MaxQDA software.
- I coded the documents, field notes, and transcripts using the MaxQDA software while I read through them.
- After completing open coding (Merriam, 2009), I proceeded to analytical coding (Merriam, 2009) stage to group relevant codes together.
- After the analytical coding, I began to look for patterns which could explain characteristics of the data.
- By sorting and analyzing patterns, I generated themes that answered the research questions sensitively, exhaustively, mutually exclusively, and conceptually congruently (Merriam, 2009).

In the next section, I describe the coding plan for the qualitative data analysis.

Coding

Table 3-17 shows the coding plan for qualitative data analysis. Code categories and sub-categories were initially produced based on the research questions. Additional codes were added during the analysis processes and existing codes were removed or modified.

Table 3-17

Code Table

Category	Sub Category	Definition
Digital literacies knowledge	- Creating - Publishing - Social interaction - Research - Digital Citizen - Research	Participants' knowledge of each digital literacy practice domain
Digital literacies skills	- Creating - Publishing - Social interaction - Research - Digital Citizen	Participants' skills about each digital literacy practice domain
Digital literacies attitudes	- Positive - Negative	Positive perceptions about digital literacy practices
Collaboration guides	- Useful - Hindering	Participants' experiences in collaboration guides
Digital literacy resources	- Useful - Hindering	Participants' experiences in digital literacy resources
Question prompts	- Useful - Hindering	Participants' experiences in question prompts
Popular culture	- Useful - Hindering	Participants' experiences in popular-culture resources
Collaboration	- Like - Dislike - Effective - Ineffective	Participants' experiences in collaboration processes
Satisfaction	- Positive - Negative	Satisfaction with projects
Constraints	- Collaboration - Question prompts - Projects - Assessment	Constraints participants faced with the project
Suggestions	- Collaboration - Question prompts - Projects - Assessment	Participants' suggestions for the project

CHAPTER 4

RESULTS AND FINDINGS: ROLES OF MULTIPLE SCAFFOLDS

In this section, I present the results and findings associated with the first research question: *How do the instructional scaffolds—collaboration guides, question prompts, digital literacy resources, and popular-culture resources—support collaborative activities during the Technology Genius Project?*

I describe the results and findings of this study from three classes: one class led by Antonio and two classes taught by me as shown in Table 4-1. The duration and frequency of Antonio's class and my classes were different. Although a majority of the activities were the same, there were variations in the sequence of activities between Antonio's class and mine. With these variations in consideration, I present the results and findings separately within each subsection.

Table 4-1

Three Classes in the Study

Classes	**Instructors**	**Class duration (days)**
A (n = 20)	Antonio	50 minutes (Monday, Wednesday, and Friday)
B (n = 20) and C (n = 21)	Me	75 minutes (Tuesday and Thursday)

The data indicated that the participants found that the multiple scaffolds were useful in general for collaborative work or learning digital literacies. The data described in the following sections indicated that the collaborative guides in the form of collaboration scripts, question prompts, and digital literacy resources offered a base for their collaborative work. Regarding popular-culture resources, the group interview participants found that the popular-culture resources were fun and relatable to learning digital literacy practices. However, there were differences between classes taught by the instructors with regard to the adoption of popular-culture resources in collaborative work. The results from the quantitative data and the findings from qualitative data are presented in the following sections.

Quantitative Results

First, participants rated the effectiveness of collaboration guides and usefulness of question prompts, digital literacy resources, and popular-culture resources on a 5-point Likert scale, ranging from "No effect" to "Strong effect" or "No use" to "Very useful."

As shown in Table 4-2, respondents from Class A reported that the collaboration guides were effective (4.150) for facilitating collaboration, and the usefulness of prompts, digital literacy resources, and popular-culture resources for learning digital literacies were reported as useful (4.150), useful (4.000), and average (3.350), respectively. The mean scores of the participants' responses of Classes B and C were higher than those of Class A. For example, the score of respondents from Classes B and C for the collaboration guides was "Strong effect" (4.718). In addition, they rated the usefulness of question prompts, digital literacy resources, and popular-culture resources as very useful (4.692), very useful (4.718), and very useful (4.513), respectively.

Table 4-2

Participants' Experiences with Diverse Scaffolds

	Class A (n = 20)		Classes B and C (n = 39)	
	M	*SD*	*M*	*SD*
Effectiveness of Collaboration Guides	4.150	1.225	4.718	.559
Usefulness of Question Prompts	4.150	.9333	4.692	.569
Usefulness of Digital Literacy Resources	4.000	1.123	4.718	.510
Usefulness of Popular-culture resources	3.350	1.182	4.513	.683

Note. Scores can range from 1 to 5.

Next, the post-survey asked participants about the activeness of collaboration, their satisfaction with collaborative work, and the final work using a 5-point Likert scale, ranging from "Inactive" to "Very active" or "Very dissatisfied" to "Very satisfied." As shown in Table 4-3, respondents from Class A reported that within-group communication and the feedback activities were active (4.450 and 4.300, respectively). They also reported that they were satisfied with the collaborative teamwork (4.300) and were very satisfied with the quality of the final work (4.600). The mean scores of participants from Classes B and C were higher than those from Class A. Respondents from Classes B and C reported that within-group communication and feedback activities were very active (4.846 and 4.513, respectively). In addition, they reported that they were very satisfied with the collaborative teamwork and the quality of the final work (4.949 and 4.821, respectively).

Table 4-3

Activeness of Collaborative Activities

Aspects	Class A (n = 20)		Classes B and C (n = 39)	
	M	*SD*	*M*	*SD*
Activeness of within group communication	4.450	.887	4.846	.488
Activeness of feedback activity from other classmates	4.350	.745	4.513	.790
Satisfaction with collaborative teamwork	4.300	1.080	4.949	.223
Satisfaction with the quality of the final work	4.600	.680	4.821	.388

Note. Scores can range from 1 to 5

The collaborative activities, which were supported by multiple scaffolds, were designed to facilitate students' collaborative learning with regard to digital literacies. I investigated the legitimacy of the collaborative activities by asking participants to rate the helpfulness of the collaborative learning activities on a 5-point Likert scale, ranging from "No help" to "Very helpful." As shown in Table 4-4, respondents from Class A reported that the helpfulness of creating video commercials for their chosen tools for learning digital literacies was average (3.300), and the helpfulness of creating a Web site, constructing a Google Docs document, creating a lesson plan, viewing other groups' work, and receiving feedback from other students was helpful (3.850, 4.200, 3.650, 4.000, and 3.900, respectively). Participants from Classes B and C reported that the activity of creating video commercials for their chosen tools, creating lesson plans, and receiving feedback from other students was helpful (4.487, 4.385, and 4.385, respectively), and the activities of creating a Web site, constructing a Google Docs document, and viewing other group's work were very helpful (4.667, 4.590, and 4.564, respectively).

Table 4-4

Helpfulness of Collaborative Activities with Regard to Learning Digital Literacies

Activities	Class A (n = 20)		Classes B and C (n = 39)	
	M	*SD*	*M*	*SD*
Co-creating a Web site	3.850	.933	4.667	.621
Co-constructing a Google Docs	4.200	1.151	4.590	.785
Co-creating video commercials for their chosen tools	3.300	1.341	4.487	.823
Co-creating a lesson plan	3.650	1.089	4.385	.781
Viewing other groups' work	4.000	1.026	4.564	.718
Feedback from other classmates	3.900	1.209	4.385	.935

Note. Scores can range from 1 to 5

Qualitative Results

Overall, three main themes and three sub-themes under the first main theme emerged from the data from the field notes of my observations, participant products, and group interviews. As indicated in the themes in Table 4-5, the findings indicated that participants found the scaffolds—collaboration guidance, question prompts, and digital literacy resources—were helpful and supportive by playing the role of guide regarding their collaborative work. However, across classes, the role of popular-culture resources was different. For example, popular culture in Class A mainly offered relatable resources for participants' learning digital literacies rather than facilitating collaborative work. In contrast, 2 groups in Classes B and 4 groups in Class C used popular-culture resources for creating their final webpages. Therefore, popular cultural resources indicated the potential as a supporting resource for students' collaborative learning in technology integration courses in Classes B and C.

Table 4-5

RQ 1 Related Themes that Emerged from Data

Themes	Sub-themes	Data/Findings
Theme 1: Usefulness of the multiple scaffolds	**Collaboration guides**: usefulness of the collaboration guides for participants' collaborative learning	Field notes, documents, interviews, and responses to the open question (Q 19) on the post-survey indicated that participants found collaboration guides useful, but some of them were initially confused about collaboration guides.
	Digital literacy resources and question prompts: offering a basic foundation for students' collaborative learning.	Field notes, documents, interviews, and responses to the open question (Q 20) on the post-survey indicated that digital literacy resources and question prompts offered a basic foundation for students' collaborative learning.
	Popular culture resources: facilitating digital literacy learning as relatable resources	Field notes, interviews, and responses to the open-ended question (Q 20) on the post-survey indicated that popular-culture resources helped students improve their understanding of digital literacies by providing relatable resources to students, but the supporting role of popular-culture resources for collaborative learning was different across the classes.
Theme 2: Learning from each other through collaboration		Field notes, interviews, and responses to the open-ended questions (Q 17 and 18) indicated that participants learned from each other through collaboration during the TGP.
Theme 3: Usefulness of the feedback activities		Field notes, interviews, participant products, and responses to the open-ended question (Q 17 and 18) on the post-survey indicated that participants generally found peer feedback activities useful, but the peer feedback design needs improvement.

Theme 1: Usefulness of the Multiple Scaffolds

Students' collaboration was guided by multiple scaffolds: the collaboration guides, question prompts, digital literacy resources, and popular-culture resources. The group interviews with participants and their answers to the open-ended questions (Q 19 and 20) on the post-survey indicated the usefulness of the scaffolds for participants' collaborative learning or digital literacy knowledge development.

In the next section, I present the roles of scaffolds in the TGP derived from the field notes of my observations.

Observation and documents. Across the TGP phase, multiple scaffolds were provided. Table 4-6 presents the relevant, observed moments in the TGP.

Table 4-6

Observed Moments regarding the Roles of the Multiple Scaffolds in the TGP

*IKB = Individual knowledge building, CKB = Collaborative knowledge building

Phases	Topics	Observed Moments of Regarding the Roles of the Scaffolds
1	Introduction	• **The introduction of scaffolds** Antonio introduced the TGP webpages and the TGP map to guide students, including where to find the TGP content. In addition, Antonio showed Model/Guidance website which included question prompts for students' collaborative knowledge building (CKB). • **Errors in the timing element of** collaboration guides As Antonio and I had agreed, Antonio told students on the second day of the TGP that he would give 10 minutes to finish creating an individual Web site on new Google Sites. However, it took an entire class period because some students missed the first class of the TGP, and some students were disengaged. • **The initial confusion of the TGP** Some students in Classes A, B, and C were having a difficult time in understanding the TGP with regard to the IKB assignments, resource pages, class Web site, and Google Docs worksheet.
2	IKB 1, CKB	• **Errors in the timing element of** collaboration guides - Antonio showed a YouTube video on an over-engineered bottle opener, which was not included as TGP resources. I was wondering how this video could be associated with the TGP because the TGP activity was being delayed. • **Guiding IKB with popular-culture resources** - I was concerned about popular-culture resources being disregarded in class A. Therefore, I asked Antonio to mention popular-culture resources associated with IKB assignments at the beginning of the TGP. Antonio did not share as much about popular-culture resources as I did with my classes. He did suggest watching the movies and dramas as IKB assignments to his students. - As Classes B and C began, I mentioned IKB 1 assignment and talked about the movie *Arrival*. I told them I was very impressed with their reflections regarding the IKB 1 assignment. I also

		talked about how they would communicate with the alien *Heptapod* in *Arrival*. After mentioning the communication topic and *Arrival,* I also mentioned IKB 2 and 3 assignments due the next week and talked about *Avengers: The Infinity War* and *The Flash*, which are related to collaboration. Regarding the IKB 3 assignment, I mentioned the drama *Westworld* and movie *Ready Player One*. I briefly talked about how virtual reality would come to reality in relation to the drama and movie. • **Confusion about Scaffolds** Some students from Classes A, B, and C were still confused about collaboration guides and CKB question prompts. Students needed guidance regarding digital literacy resource pages. • **Co-constructing digital literacy knowledge following the collaboration guides** - Students from Classes A, B, and C focused on creating the explanation section in a Google Docs worksheet following the collaboration guides and question prompts - Students utilized digital literacy resources provided to answer the guiding questions. • **Learning digital literacy practice with popular culture resource** - Students watched the clips of movie *Arrival* to learn about *communication* digital literacy practice as an IKB activity
3	IKB 2, CKB	• **Guiding between-group collaboration** - Students from Classes A, B, and C focused on giving feedback on two other groups' work (+1 and +2 groups) and updating their sections based on the feedback comments. - I found the CSCL script of giving feedback to other groups worked very well. Antonio and I agreed on the high quality of the feedback. I felt that students from class A began to understand the collaboration guides. • **Learning digital literacy practice with popular-culture resources** -Students watched the clips of movie *Avengers: Infinity War,* the drama *The Flash* and the movie *The Wizard of Oz* as an IKB activity on *collaboration* digital literacy practice.
4	IKB 3, CKB	• **Guiding video commercial plan with resource pages** - Some groups from Class A began to design a video commercial plan. Research group (A) asked Antonio about digital literacy resource pages. Antonio showed them the research resource page and the tools. I thought that this incident showed the necessity of digital literacy resource pages. Creating and publishing group (A) also asked for the resource pages. - Students focused on designing video commercial plans according to the video commercial plan template. • **Resolve of Initial Confusion about the TGP**

		Students' initial confusion appeared to be resolved because they followed guidance without much difficulty. • **Learning digital literacy practice with popular-culture resources** - Students watched the clips of drama *Westworld* and the movie *Ready Player One* as an IKB activity on the *creating* and *publishing* digital literacy practice.
5	IKB 4, CKB	• **Between-group collaboration based on the collaboration guides** - Students from Classes A, B, and C focused on giving feedback on two other groups' work (+3 and +4 groups) and updating their sections based on the feedback comments. • **Learning digital literacy practice with popular-culture resources** - Students watched the clips of drama *Black Mirror*'s "Nosedive" episode as an IKB activity on *digital citizenship* digital literacy practice.
6	IKB 5, CKB	• **Guiding lesson plan design** Students from Classes A, B, and C focused on designing lesson plans using the lesson plan template. • **Learning digital literacy practice with popular-culture resources.** - Students watched the pop songs (Class Idea and Another Brick in the Wall) and a TED Talk from School in the Cloud to learn about *research* digital literacy practice.
7	IKB 6, CKB	• **Guiding feedback activities** - Antonio began his class with the explanation of the rubric regarding their constructive feedback. - I felt that some students in class A did not read the rubric carefully because a student did not know the feedback was an individual one. - I regretted having not emphasized the feedback rubric part and making it clear in Classes A, B, and C. Some students gave complimentary feedback such as "cool" and "great" to meet the minimum number requirement of feedback comments. • **Learning digital literacy practice with popular-culture resources.** - Students watched the clips of the movie *The Imitation Game to* learn about *problem-solving* digital literacy practice.
8	Video Commercials Creation	Students were guided to create their video commercials independently at their chosen places and publish their video commercials before the phase 9 class.
9	Webpage design and publishing	Students were guided to design webpages which communicate their messages with multimodal media
10	Presentation	• **Errors in the timing element of** collaboration guides

		Students in Class A presented their work over two class periods. Therefore, they had enough time for their presentations. However, students in Classes B and C were pressured to finish their presentations within 7 minutes. The timing element of collaboration guides did not work well in Classes B and C in this regard.

Table 4-6 presents the observed moments regarding the roles of multiple scaffolds in the TGP in general. As Table 4-6 shows, there was initial confusion about the TGP because students had a difficult time in understanding the class Web site, resource pages, Google Docs worksheet, IKB assignments, and guiding questions (question prompts) presented to them. However, after the phase 2, it appeared that students began to understand how to use the Google Docs worksheet, answer guiding questions, give feedback, and use resource pages because they followed the collaborating guides, which specified how to use resources and to collaborate, without difficulties.

As a result, it seemed that the collaboration guides played the role of guiding students to the goal of communicating collective knowledge in association with guiding questions, digital literacy resources, and popular-culture resources. However, as indicated in Table 4-6, among the elements of collaboration guides in the form of CSCL scripts (see Dillenbourg, 2002), the timing elements did not work very well in Class A. The beginning of the TGP was delayed for about 5 minutes because Antonio had to guide his students regarding his course-specific projects and often showed some videos which were not included in the TGP design but seemed related to the TGP topics. For example, in phase 2 in Class A, my field notes recorded what happened in the beginning of Class A:

> **9:00 a.m.**: The class began. The instructor showed the video on over-engineered bottle openers. I was wondering how this video could be associated with the TGP.
> **9:05 a.m.**: The instructor seemed to introduce the bottle opener to show a YouTube channel for making artifacts, which seemed to be related to a project in Class A. The

> instructor introduced the project which was specific to Class A, showing and explaining his course schedule.
> **9:11 a.m.**: Then, Antonio announced the TGP individual knowledge building (IKB) assignment 2 and shared Flipgrid (a video communication tool) access code for the Tech force/Model lesson activity and told that they could try Flipgrid before Friday's class.

In addition, some participants from Class A came to class late or missed classes. Because the duration of the class was 50 minutes, some of them, as a result, were unable to achieve all of the goals set for the class because of lack of time or lack of knowledge and skills. Some participants from Classes B and C also came to class late, but they were able to catch up with other students because their classes were 75 minute long. Therefore, I began to be concerned about the limited time for Class A students to build their collaborative knowledge. As a way of ensuring time for collaborative knowledge building, the Tech force/Model lesson activities had to be implemented in reduced forms—shortened activity hour and omission of a block coding practice at Code.org—because there were no more available times in Class A for the TGP. As a result of this measure, students from Class A could have time for collaborative knowledge building (CKB) activities so that they could finish the project in 5 weeks.

The supporting roles of multiple scaffolds indicated in Table 4-6 were facilitated by several interventions. As Antonio and I wanted students to access and use the multiple scaffolds easily, Google Sheets, Google Docs, and webpages were provided to help students locate and use the multiple scaffolds without problems at any phases of their activities. For example, the TGP maps were offered to help students understand how they could achieve the goal of designing and publishing their webpages, as shown in Figure 4-1. Students from Classes A, B, and C used the TGP map of each class to find out what they were expected to do on each day.

The TGP Map for Class A

Technology Genius Project Course Map				
Course Homepage				
TGP week 1	9/10 (Mon)	TGP1 - New Google Site	TGP Assignment 1 (communication)	Before class on 9/12
	9/12 (Wed)	TGP2 - Initial Document Creation1	TGP Assignment 2 (collaboration)	Before class on 9/17
	9/14 (Fri)	TGP2 - Initial Document Creation2		
TGP week 2	9/17 (Mon)	TGP3 - Feedback to +1 & +2 Group and Update your document	TGP Assignment 3 (creating & publishing)	Before class on 9/19
	9/19 (Wed)	Tech Force 1 (Model Lesson)	TGP Assignment 4 (digital citizenship)	Before class on 9/24
	9/21 (Fri)	Tech Force 2 (Model Lesson)		
TGP week 3	9/24 (Mon)	TGP4 - Create Tool Commercial Proposal	TGP Assignment 5 (research)	Before class on 9/26
	9/26 (Wed)	TGP5 - Feedback to +3 & +4 Group and Update your document	TGP Assignment 6 (problem solving)	Before class on 10/1
	9/28 (Fri)	TGP5 - Update your document and Create Lesson Plan		
TGP week 4	10/1 (Mon)	TGP6 - Feedback to +5 Group		
	10/3 (Wed)	TGP7 - Update your document and complete explanation and lesson plan section of your webpage		
	10/5 (Fri)	TGP8 - Video Creation Day		
TGP week 5	10/8 (Mon)	TGP9 - Publishing day		
	10/10(Wed)	TGP10 - Presentation Day1		
	10/12(Fri)	TGP10 - Presentation Day2		

The TGP Map for Classes B and C

TGP Week 1	9/11 (Tue)	Technology Genius Project (TGP) - Introduction	TGP1 - New Google Site	TGP Assignment 1 (communication)	9/13, before class
	9/13 (Thu)		TGP2 - Initial Document Creation	TGP Assignment 2 (collaboration)	9/18, before class
TGP Week 2	9/18 (Tue)		TGP3 - Feedback to +1 and +2 Group	TGP Assignment 3 (cre. & pub.)	9/20, before class
	9/20 (Thu)		TGP4 - Creating Tool Commerical Plan	TGP Assignment 4 (digital citizenship)	9/25, before class
TGP Week 3	9/25 (Tue)		TGP5 - Feedback to +3 and +4 Group	TGP Assignment 5 (research)	9/27, before class
	9/27 (Thu)		TGP6 - Creating Lesson Plan	TGP Assignment 6 (problem solving)	10/2, before class
TGP Week 4	10/2 (Tue)		Feedback to +5 Group / Update and Publish		
	10/4 (Thu)		TGP 8 (video creation day)		
TGP Week 5	10/9 (Tue)		TGP 9 - Update and publish		
	10/11 (Thu)		TGP10 - Presentation Day		

Figure 4-1. The TGP maps for classes

In addition, students also used a Google Docs table composed of hyperlinks to the TGP activities, six individual knowledge building (IKB) assignments, and resource pages shown in Figure 4-2. Participants used this table to access resources and related activities pages without leaving the Google Docs worksheet they were working on because the table was located at the top of each class Google Docs worksheet.

Technology Genius Project

Creating a website about digital literacy together

Warp For Space Travel

Group Specific (Check group members)						Whole Class	
Digital Literacy (Each initial digital literacy practice document will be circulated among groups)		Components (Model / Guidance Site)			Resource Website pages	Assignment Website Pages (Due Date)	Course Website Pages (Activity Date)
		Expla nation	Tool Video	Lesson Plan			
1	Communication	Jump	Jump	Jump	Com.	TGP Ass. 1 (9/12)	TGP1 (9/10)
2	Collaboration	Jump	Jump	Jump	Coll.	TGP Ass. 2 (9/17)	TGP2 (9/12)
3	Create / Publish	Jump	Jump	Jump	Cre./Pub.	TGP Ass. 3 (9/19)	TGP3 (9/17)
4	Digital Citizen	Jump	Jump	Jump	Digi.Citi	TGP Ass. 4 (9/24)	TGP4
5	Research	Jump	Jump	Jump	Res.	TGP Ass. 5 (9/26)	TGP5
6	Problem solving	Jump	Jump	Jump	Pro.sol.	TGP Ass. 6 (10/1)	TGP6 (9/26)
Final update of your group's document based on the feedback							TGP7 (10/1)
Completion of the explanation and lesson plan part of your group's webpage							TGP8 (10/3)
Video Creation Day		Create the infomercial video and update your group's webpage (10/5)				Tool Video Resources	
Publishing Day		Designing and publish web pages (10/8)					
Presentation		Peer evaluation (10/10,12)				Rubric	

Figure 4-2. Activity and resource page guidance through the Google Docs worksheet of Class A.

After two weeks passed since the beginning of the TGP, Antonio suggested providing students with an image that showed the TGP workflow because he thought that his students did not have the whole picture regarding the project. Therefore, I created the diagram shown in Figure 4-3 and presented it on every TGP page so that his and my students could get the whole picture of the TGP. I expected that students understood what they needed to utilize through the diagram which showed they needed to refer to Model/Guidance website for the guiding questions, sample lesson plans, model Web site, resource pages, and rubric.

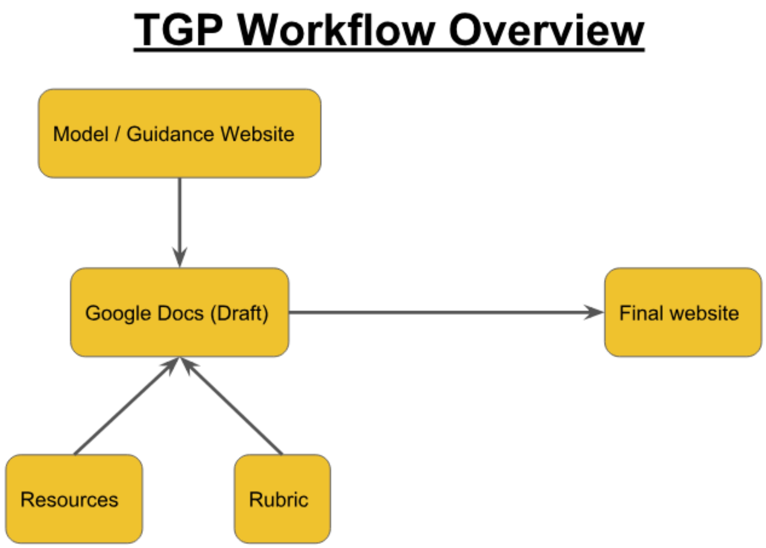


Figure 4-3. TGP workflow diagram

The TGP maps, Google Doc tables containing hyperlinks, and TGP workflow diagram seemed to contribute to helping students understand the collaboration guides and use multiple scaffolds without difficulties. In association with these interventions, students accessed the digital literacy resources to conduct research regarding their groups' digital literacy practice(s). As shown in Figure 4-4, the digital literacy resource pages were composed of explanations about each digital literacy practice, recommended tools for the digital literacy practice, and examples of lesson plans or activities for each digital literacy practice. Students also accessed popular-culture resource pages to complete the six individual knowledge building assignments.

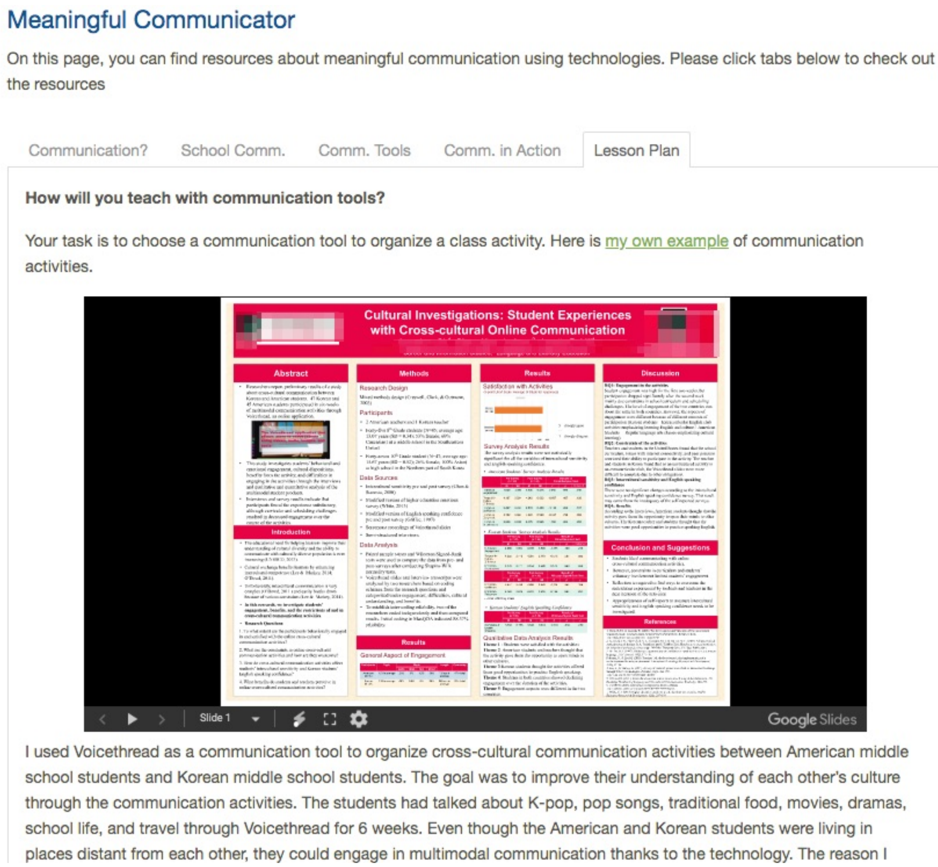


Figure 4-4. Section of the *communication* digital literacy practice resource page

As mentioned earlier, participants used the Model/Guidance Web site (see Appendix K) to access guiding questions in the form of question prompts and to confirm what the final Web site would look like. Participants used the digital literacy resources and popular-culture resources to find information, tools, and pedagogical knowledge of technology integration regarding each digital literacy practice. The TGP rubric also guided the students on how to create the explanation sections, video commercials for their chosen tools, and lesson plans. Students built their collective knowledge using the Google Docs worksheet, which was at the center of students’ collaborations. Students also used the video commercial plan and lesson plan template, which were embedded in the Google Doc worksheet, to create video commercials for their chosen tools and lesson plans. After about two weeks had passed, the initial confusion about the

TGP dissipated, and it seemed that most students generally understood the phases, modes, and timing of the TGP. In the next section, I present interview findings regarding collaboration guides.

Collaboration guides in Class A. I asked participants about their experiences with the collaboration guides. Amelia and Emma (A) responded as follows:

> **Amelia**: I think they were helpful_
> **Emma**: Yeah…
> **Amelia**: _I mean they it kind of gave us a base for how we collaborate with each other and what works best in everything so.

Amelia stated that the collaboration guides were helpful because they provided a base for their collaborative work. Amelia indicated that the collaboration guides showed them the mode of collaborative work and organized activities so that collaborative work could be done effectively. Similarly, regarding the collaboration guides, Andrea and Amanda (A) responded as follows:

> **Andrea**: I think the guide served as a nice reminder I guess. Maybe if one of us is busy that like, hey this is a group project, and we should work together and not only that, when it comes to the time for feedback and stuff like you should collaborate with other groups too, and that was kind of like the fact that that was an expectation in the project. It was kind of nice that you knew it was a standard all across the board, and you weren't getting us doing all the work.
> …
> **Amanda**: I actually really liked it. Um, just kind of getting to see like not only like each other's progress but getting to see all the other groups' progress as well. Um, we were just all able to like really like just scroll over like everyone's work, and just like, okay, like we need work here, alright where we definitely have a good understanding on this topic, but yeah, it was nice to just like see our progress and everyone else's.

Andrea and Amanda described in what ways the collaboration guides were useful. For example, Andrea indicated that she knew what to do because of the collaboration guides. In addition, she also appreciated that the collaboration guides streamlined the collaborative work by helping them focus on the required work. Amanda indicated that the collaboration guides, which asked students to review other groups' work and leave comments for them, were effective as intended.

Collaboration guides in Classes B and C. Interview participants from my classes (Classes B and C) also found the collaboration guides useful. For example, regarding their experiences with the collaboration guides, Jane, Anne, and Sophia (B) responded as follows:

> **Jane**: I think it was pretty clear.
> …
> **Anne**: And having the example Web site helped us to see what we were supposed to do.
> …
> **Sophia**: And it was nice. So, we were provided like resources and stuff and we weren't just like left to dry, like hung out to dry.
> **I: And how did you feel about that directions about giving feedback you know plus 1 group 2 plus 1 go to plus 2 group?**
> **Anne**: It made sense, yeah, after we understood like the first time what you meant by that, it made sense for the rest of the time right.
> **All**: Yeah yeah

Jane, Anne, and Sophia explained their experiences with the collaboration guides, which were provided in association with question prompts and resources. For example, Anne indicated that the Model/Guidance Web site, which guided their collaboration with question prompts and the model Web site, gave them direction regarding their collaborative work. Anne also indicated that the collaboration guides about giving feedback to other groups in turn were rational. In addition, Sophia explained that resources were useful to them. Similarly, regarding the collaboration guidance about giving feedback, James and Nadin (B) stated:

> **James**: It was good. It worked well. I mean I think everything we did or a lot of what we did was new technology to a lot of us. So, that was good to get some resources.
> **Nadin**: I agree. I think it allowed us to kind of see what each group was doing.

James and Nadin indicated that the collaboration guides regarding giving feedback were effective and useful because the collaboration guides allowed them to explore and learn new technology that other groups introduced to them. Similarly, Chris and Jasmine (C) indicated that the collaboration guides were easy to follow and useful for them:

> **Chris**: I think it was very easy to follow. It was very helpful.
> …
> **Jasmine**: They were pretty clear step by step instructions. So, I mean and we took it like one step at a time. So, I think it was clear. It was good.

Chris and Jasmine indicated that the collaboration guides provided structured sequences about phases and clear instructions on each task, guiding their collaborative learning in a step by step process. Regarding the takeaway from the TGP, Megan, Ava, and Luke (C) responded as follows:

> **Megan**: I think mine was mostly with providing feedback, the commenting on and collaborating with everyone, just getting to use that more and how to work as a group and yeah…
> **Ava**: I think it was nice to like present the project as well because like as a teacher like that's what you will be doing, is to be sitting in front of people, and like you'll need to present like your work or like I don't know like a concept to the class so like that was beneficial because we got to like create a lesson plan, apply what we knew, be creative and like make like the Ozobot thing and then…
> **Megan**: Yeah, it gives you a lot of opportunity to go back and learn about problem solving.
> **Ava**: And then also seeing other people's like I kind of wish they had a little bit more time just because like some of them are actually like really interesting, but I guess like seeing the overall project and sharing.
> **Luke**: Yeah, I think like definitely like collaboration and working together kind of seeing how valuable that was especially in tackling a big task like that and also like the value of breaking things down into smaller sections to like make something bigger, so you don't get intimated by the big task…

Megan, Ava, and Luke commonly indicated that they liked the collaborative aspects such as giving feedback on other groups' work and co-creating the class Web site. Luke specifically indicated the effectiveness of the collaboration guides by mentioning the usefulness of phased and structuralized activities in the TGP, which made it possible for them to complete the final project in the end without being intimidated. In addition, Ava mentioned her positive learning experiences with the final phase of the collaboration guides, which asked students to present their final work to classmates and review other groups' work.

The TGP, however, was a complex project, with multiple phases and multiple tasks in each phase. Even though the instructors tried their best to explain the project in detail, some participants were confused about the collaboration guidance at the beginning of the project. Interview participants from Class A did not mention about the confusion. However, some participants from Classes B and C mentioned the confusion they felt. For example, regarding the suggestions for the TGP, James (B) and Rachel (C) responded as follows:

> **James (B)**: I think it started out it's very confusing, and I just I didn't really know anything going on. I think it was good in the sense that there wasn't like anything big and once there wasn't any big leaps. It was just all little stuff all along, and then like you can't. It was, it was cool to see how I kind of clicked into place eventually anyway
> …
> **Rachel (C)**: I was, could honestly say, it's pretty well planned out. I don't know anything, at first, I was like why am I doing this? Why am I doing this? Why am I doing this, and it actually helped tremendously, and it all made sense at the end of like why you had to do each thing.

James and Rachel indicated how complex the TGP was by stating they did not know the reasons behind specific activities, which could be compared to puzzle pieces comprising an entire image. Even though the instructors tried to explain the purposes of each activity, it was possible that students could not understand how and where specific activities fit together as parts of an entire project. However, Rachel also mentioned that the initial confusion disappeared as time went on, and eventually the project design was very helpful for her.

So far, I have presented the findings regarding collaboration guides. Students also found question prompts and digital literacy resources offered a basic foundation for their collaborative research as shown in the following section.

Question prompts in Class A. Guiding questions were associated with the explanation section of each group's webpage. Antonio and I specifically instructed students to find 7 guiding questions on the Model/Guidance Web site. Each group copied the set of 7 guiding questions corresponding to their group's digital literacy practice from the Web site, pasted them to the Google Docs worksheet, and began to investigate each question. Some groups had difficulty in understanding what to do with the first guiding question. For example, the problem-solving groups from each class were asked to answer the following question: "What is the question your group wants to investigate about the digital literacy practice of *problem solving*? Please answer your group's question." Some participants asked about the meaning of the first question, and Antonio and I guided them to think about what they wanted to explore regarding their group's digital literacy practice in addition to the other six guiding questions. After they decided on their group's first investigation question, most participants seemed to have no problems with understanding the other questions.

After the student groups understood the guiding questions, they began to build their collective knowledge regarding digital literacy practices by investigating the 7 guiding questions. I investigated how the question prompts facilitated participants' collaborative learning through group interviews. Regarding the role of guiding questions, Andrea and Baker (A) responded as follows:

> **Andrea**: I just think they really helped with the structure of the projects, like problem solving is such a big concept that I wouldn't have even really known where to start after what is problem solving. I wouldn't have known kind of what direction to go to. So, having those guiding questions or is like, oh, what is design thinking? What is computational thinking? I think they gave us more direction to kind of ahead with our with our project in general and with our thoughts and kind of what we wanted to get across with the Web site with everything we did afterward.
> …

> **Baker**: I think I also felt the same way, like the guiding questions kind of give the directions that how we start this project and then how to follow more further question and or thinking. So, I think that's helpful, like getting more specific question, yeah.

Both Andrea and Baker mentioned that the question prompts played the role of giving them direction about where to go regarding their collaborative knowledge building activities. Andrea and Baker indicated that the question prompts served the purpose of supporting their collaborative learning by offering instructional scaffolds for their research. Regarding the guiding questions, Amelia and Emma (A) also responded as follows:

> **I: Yes, and how did the guiding questions, the guiding questions help you collaborate with each other?**
> **Amelia**: They were very helpful. It kind of explained further, and it just gave a clear explanation of what it is and so, it just made it really clear. We could understand it well.
> **I: Yeah and how did you come up with your own investigating question?**
> **Amelia**: I think we just kind of brainstormed ideas of what we were interested in.
> **Emma**: We were curious about collaboration.
> **I: Uh mm could you tell me about processes of answering those guiding questions and your own question? How did you answer those, you know?**
> **Emma**: Umm, I think we did a little more research on collaboration just so we knew like everything about it, and then we just worked together on answering the question.

Amelia and Emma explained the role of guiding questions clearly. For example, Amelia indicated that the guiding questions themselves were helpful explanations of the digital literacy practice that her team focused on and gave them confidence in conducting research on the digital literacy practice. Amelia and Emma also explained the supporting role of the guiding questions, which asked them to create their own investigation question on their group's digital literacy practice. They indicated that their team discussed what they would explore and did further research on their investigation question.

Question prompts in Classes B and C. Interview participants from Classes B and C also found question prompts useful. For example, regarding the guiding question, Nadin (B) stated:

> It made us understand our learning style a little bit better 'cause we got to understand like what it was really about, and then there was one question we had about like I forgot his name like the researcher and everything, and it kind of like gives a little bit of background into like the scholarly side of like that topic. So, I feel like it just gave us a little bit more in-depth understanding than what our basic like surface level understanding would have been.

Nadin referred to digital literacy practices as "learning style," and could not remember the name of Vygotsky, who was the researcher mentioned in one of the guiding questions for her group. However, she indicated that the guiding questions helped her group understand *collaboration* digital literacy practice (her group's digital literacy practice) in depth. In addition, regarding the guiding questions, Odin (C) said the questions "helped us … approach the topic from different angles." He indicated that the guiding questions played the role of giving his group diverse perspectives for investigating its topic. Similarly, Luke, Ava, and Megan (C) also responded as follows:

> **Luke**: I mean it definitely like helped us define the things that we needed because like for us, it was a, it was like, gosh, what were the problem-solving skills, it was a, oh my gosh, computational thinking_
> **Ava**: Design thinking
> **Megan**: Yeah
> **Luke**: _design thinking and like those things are kind of like the core of what problem-solving is, and so I thought it was definitely like necessary that we need to know what that was. So, it was nice like have the questions that we really needed to like to understand what problem, because if not, then we would've just been like Googling like problem solving and get definition there like there could've been all different kinds of things would have known, but it was like the guiding questions helped us understand fundamentally what we were trying to.
> **Megan**: Yeah, I agree, yeah.
> **Luke**: It was, I also like that there wasn't like to like too many of them. So it helped it like it was we could go more in depth on the specific ones that we had rather than just like have to like put some answer for all these questions, and it was good there was like what's it, seven I think?

Luke indicated that the guiding questions helped them define core skills for *problem-solving* digital literacy practices such as design and computational thinking. Luke and Megan indicated that the guiding questions facilitated their collaboration by offering them common ground for their investigation into *problem-solving* digital literacy practices. Luke also indicated that the number (7) of the guiding questions was appropriate for them to investigate in depth.

At present, data from group interviews indicated that digital literacy resources and question prompts offered a basis for students' collaborative work by giving them a foundation for the topic or direction to follow. The multiple scaffolds provided were designed to support students' collaborative knowledge building. The findings from the group interviews indicated that the scaffolds provided participants with a basis for collaborative learning. There was indication that digital literacy resources played a similar role for students' collaborative learning with question prompts, as shown in the following section.

Digital literacy resources in Class A. Digital literacy resources were provided to students to support their collaborative learning through resource webpages and individual knowledge building assignment webpages. Antonio and I wanted students to easily find the resources and use them for collaborative learning. Therefore, the hyperlinks for digital literacy resources were available on the TGP webpages as well as each class's Google Docs worksheet. Therefore, students did not seem to have difficulty in accessing the digital literacy resources.

Group interviews with participants indicated that the digital literacy resources were useful for their collaborative learning. For example, regarding the role of the digital resources in their group's collaborative work, Andrea (A) stated:

> I mean it made it nice that we could all kind of look at the same thing, and so we were all kind of working off of the same information so that when we collaborated, we knew exactly what the other was talking about. It wasn't like "Hey, I found this one article somewhere," and they were like "Okay, but like I can't find that I can fact-check you or like talk to you about that." So, it's nice that we were all looking at, we'd all done the same assignments. So when you would say like "Oh, that clip from the *Imitation Game*," they would be like "Oh yeah, I know exactly what you're talking about," like we all watch the same thing and so to use that as an example, it's helpful for us to like

> collaborate and kind of know, have the same base of where we were working from and then branch off of their own ideas from there.

Andrea recognized the facilitating role of the digital literacy resources for their collaborative work. This supporting role of the digital literacy resources indicated that they supported learners' collaborative learning processes by offering a base for students' work. In addition, Andrea also explained that the resources on the individual assignment pages, such as movies and dramas, offered a sharing space for their groups for collaborative work. Similarly, regarding the role of the digital literacy resources, Amelia and Emma (A) responded as follows:

> **Amelia**: I think that, I mean they were just really clear, and it gave us a lot of information, but it was easy to read. I know sometimes when I research stuff, it's hard to understand, but these weren't. So, it gave us a lot of helpful information on our topic.
> **Emma**: Yeah.

Amelia indicated that the digital literacy resources were clear and helpful for them because they provided information for their topic of digital literacy practices. The digital literacy resource webpages included information about each digital literacy practice, tool introduction for each digital literacy practice, and exemplary lessons for digital literacy practices. Amelia's response confirmed that the digital literacy resources can play the role of supporting collaborative knowledge building processes.

Digital literacy resources in Classes B and C. Similarly, interview participants from Classes A and B found digital literacy resources were useful. For example, regarding the digital literacy resources, Nadin (B) stated:

> For ours, I know like we would go back and look at like the different tools, those stuff that you've provided, mmm, as far as like seeing different like collaboration tool. Ultimately, we chose like the Google Drive, but there were other ones that were like really good ones as well that we could have used. So, I feel like the tools that you provided I know like, for other groups, might have been very useful especially for like topics, and it might not be used on a like day to day basis like those kinds of tools. I appreciate they were very like useful like seeing the different tools and kind of be able to explore throughout and kind of just seeing which one they liked best.

Nadin also indicated that the digital literacy resources supported their collaborative learning by offering them information about diverse tools and helping her group choose Google Drive as her group's focus tool. The group interview participants from Class C also indicated the helpfulness of the digital literacy resources for their collaborative learning. For example, Luke and Megan (C) responded as follows:

> **I: Yeah, I see. So, how did you research to answer the questions?**
> **Luke**: Just like Google.
> **Megan**: Just used the resources that we used in the homework, too. I think we use you have those resources.
> **Luke**: Yes, that's true.

Luke indicated that he searched Google to answer the guiding questions. In addition, Megan indicated that they used digital literacy resources to accomplish the collaborative knowledge building (CKB) activity. Their responses indicated that along with the Google search tool, digital literacy resources were usefully utilized for their collaborative learning. Similarly, Chelsea and Rachel (C) responded as follows:

> **I: I see. So, what did you research to answer the questions?**
> **Chelsea**: You gave us, uh, you provided us with links to like videos and different tools that we could look through.
> **Rachel**: That would help us like gain knowledge of like the concepts.

Chelsea and Rachel indicated that the digital literacy resources offered a base for their collaborative knowledge building, which suggests these resources can build a foundation for digital literacy practices.

In addition to scaffolds discussed so far, I also investigated the role of popular-culture resources in the TGP. As shown in the following section, popular-culture resources helped students improve their understanding of digital literacies by providing relatable resources to students, but the supporting role of popular-culture resources was different across the classes.

Popular-culture resources. In addition to digital literacy resources, popular-culture resources such as movies, dramas, and pop songs were provided to maintain the students' attention, help them build knowledge of digital literacies, and offer common ground for their collaborative knowledge building. Each popular culture resource was provided through its own webpage or through YouTube videos. The hyperlinks for each movie, drama, and pop songs were provided through individual assignment pages, a Google Docs worksheet for each class, and digital literacy resource pages.

Popular-culture resources were closely tied to individual knowledge building (IKB) assignments. I expected that the introduction of popular-culture resources as individual assignments would play a supporting role for students' collaborative knowledge building (CKB) activities as well as facilitating knowledge building by attracting the attention of students. The data revealed that in general, popular-culture resources successfully maintained most students' attention and helped them build digital literacy knowledge. However, the supporting role of popular-culture resources for collaborative learning was not substantial in Class A. In contrast, the popular-culture resources showed the potential to facilitate collaborative learning in digital literacy courses in Classes B and C.

Participants were expected to watch popular-culture resources such as movie clips and listen to pop songs through individual knowledge building assignments and submit their reflections on the popular-culture resources in relation to each digital literacy practice. The approach to popular-culture resources by Antonio and me was different. There were differences in our familiarity with the popular-culture resources. I had watched and understood all the movies, dramas, and pop songs very well. However, Antonio had not watched most of the movies, dramas, and pop songs. While not confirmed with Antonio, this may be the reason he did not share his thoughts actively with the students about the popular-culture resources with regard to digital literacy practices.

Therefore, the students from my classes (Classes B and C) were exposed to popular-culture resources more than the students from Antonio's class (Class A) because I incorporated them more actively into classes. I shared my thoughts about the resources and asked students' their opinions about them. As a result, I found that 6 groups among 12 groups in my classes (Classes B and C) included content related to popular-culture resources in their published webpages, but I could not find such cases in participant products from Antonio's class (Class A).

Popular-culture resources in Class A. As indicated in the previous section, the supporting role of popular-culture resources was different across classes and groups. However, the data from interviews mainly indicated that popular-culture resources helped students improve their understanding of digital literacy practices by offering relatable and fun resources. For example, regarding popular-culture resources, Amanda and Andrea (A) responded as follows:

> **Amanda**: I think for me like just like definitely putting it in and kind of like a perspective like especially our generation can understand. Um, I think it was like with the *Avengers,* it was collaboration, and I had seen them. I'm a huge Marvel fan. So like I've watched that forever ago, but so like just seeing that like, oh yeah, it's like that's what collaboration is, and then like it kind of like went with the same flow like each time I was like that's like a good example just kind of like putting it like in an actual like example, and you can visually like see that example like living out so.
> …
> **Andrea**: I think it just made it more fun, too. Just to like add that element of you're not watching like a lecture again, like you're watching something fun that you're like, "Ooh action and fighting and collaboration."

I offered clips from the movies *Avengers: Infinity War* and *The Wizard of Oz* and from the television series *The Flash* for individual assignments for the collaboration digital literacy practice. Amanda indicated that as a Marvel movies fan, the *Avengers* movie was relatable to her and became a good example for her when she was learning what collaboration was. Similarly, Andrea said that the popular-culture resources were fun and relatable because they were not lectures but resources which had elements she liked, such as action. In addition, regarding experiences with the popular-culture resources, Amelia and Emma (A) responded as follows:

> **Amelia**: Um, I think they were pretty helpful. I mean I'm the one that sticks out to me the most was that movie about how they rate everyone. Do you remember?
> **Emma**: Oh yeah um
> **Amelia**: I just think it was really relatable so.
> **Emma**: Yeah
> **Amelia**: Um, but it kind of opened your eyes to see how it, the issues and everything relates back to our world so.
> **Emma**: Yeah.
> **I: Yeah you mean the *Black Mirror*, "Nosedive" right?**
> **Amelia**: I don't remember
> **Emma**: It was the one where they rate like the movie, uhhmm.
> ….
> **Amelia**: Mmm, sorry but I think it just really kind of opened my eyes because I think our world is so focused on technology and just social media and all that.
> **Emma**: It just showed the downside of some technology.
> **Amelia**: And just a lot of people let it consume them, and so, I think it's important to have that as a part of your life, but not let it take over your life…so.
> …
> **Emma**: I mean *The Wizard of Oz* they all work together trying to find where to go. So I guess that was helpful to really understand what collaboration was.
> …
> **Amelia**: Um, I mean I think like she was saying about *the Wizard of Oz,* it just showed us that you can all work together to come to meet a goal.

First, Amelia indicated how relatable and helpful the "Nosedive" episode of the drama *Black Mirror* was for her reflection on aspects of technology and social media even though she could not remember the title of the episode. In addition, Emma also indicated that *The Wizard of Oz* was relatable to her regarding the topic of collaboration. The "Nosedive" episode seemed especially memorable to participants as also indicated in the interviews with the participants from Classes B and C in the following section.

Popular-culture resources in Classes B and C. Popular culture also became relatable resources to interview participants for Classes B and C. For example, regarding his experiences with popular-culture resources, James (B) responded as follows:

> **I: Oh, so, how did the popular culture such as movies and pop songs help you understand the digital literacy practices?**
> **James**: It just gives us something to compare it to, relate it to. It's like comparing like, you see the dangers of it, stuff like *Black Mirror*, and then you see some other difficulties in *Arrival*. You see like collaboration and different things in *Avengers*. So, I mean it's already things that we associate those movies and TV shows with but then to kind of connect the dots with technology. So, I mean you already think of *Avengers* and you think of teamworks [sic] you know you kind of connect that with collaboration.

James also indicated that *Arrival* and "Nosedive" were relatable to him for learning digital literacies and that through *Arrival* and "Nosedive" he recognized the negative aspects of technology or the difficulties of digital literacy practices. In the same way, he also related the movie *Avengers: The Infinity War* to collaboration in digital literacy practices.

Rachel (C) also referred to the "Nosedive" episode when she was asked about digital citizenship. For example, she stated:

> Digital citizenship, uh it's like how, what you put out in the world. It's very important like I keep remembering, that's the one where we watch the *Black Mirror* episode, like you're unconsciously like making these judgments of people, and like what you put out into the world isn't always private, and people could talk about that even afterwards, and it's just you want to create a good image for yourself.

Rachel indicated that she realized the importance of establishing adequate digital citizenship watching the "Nosedive" episode. Her response indicated that the "Nosedive" episode facilitated her learning in terms of adequate digital citizenship establishment. Similarly, regarding learning digital literacies with popular-culture resources, Luke and Ava (C) responded as follows:

> **Luke**: I think it helped like because obviously is like we could understand like, what is problem-solving, what is design thinking, but then it was like that's there's a difference between understanding that and actually like seeing how its applied unlike the real world
> **Ava**: It's an example.
> **Luke**: It's an example of like how we can actually implement that, implement problem-solving skills like an *Imitation Game,* Alan Turing like makes the computer the prob… it's like solve a problem, and it's like that's him. You can like look, watch the movie and like kind of define like his actions through like the basics of problem solving.
> **Ava**: And that's something like you don't see prior till until like learning about like problem-solving and design thinking and stuff like that because like you just watch the movie and you like, "Oh, they're like all working together. The common goal." You know, but like then you get to connect it to something that like you're learning, which is cool.
> **Luke**: Yeah

Luke indicated that popular-culture resources such as the movie *The Imitation Game* were relatable to him and helped him understand what problem solving and design thinking is. Luke's response indicated that popular-culture can be a relatable resource useful for helping learners understand what digital literacy practices are and can be. Ava also confirmed that watching the popular-culture resources was a nice experience and helped her learn the *problem-solving* digital literacy practice.

Students' adoption of popular-culture resources in their collaborative work in Classes B and C. 6 groups—two groups from Class B and four groups from Class C—included popular-culture content in their work (see Appendix L), although participants were not required to integrate popular-culture resources into their final product. Participant groups from Class A did not include popular-culture resources in their work, but six groups among 12 groups from Classes B and C incorported diverse popular-culture resources to describe their groups' digital literacy practices. For example, the digital citizenship group from Class B refers to "Nosedive" to explain the importance of digital citizenship. Furthermore, the research group from Class C mentioned the song "Another Brick in the Wall" to explain how educators can improve teaching and learning by implementing *research* digital literacy practices in K-12 schools. This indicated that popular-culture resources were influential for some groups with regard to their collaborative knowledge building.

The following section shows findings from participant responses to the post-survey open-ended questions (Q 19 and 20) relevant to scaffolds.

Participants' responses to the open-ended questions regarding scaffolds. I investigated the usefulness of the multiple scaffolds through the open-ended questions (Q 19 and 20) on the post-survey. First, I investigated the usefulness of collaboration guides. Not all the participants answered the open-ended question (Q 19), but all the submitted responses (17 responses among 61) indicated the usefulness of the collaboration guides, as shown in Table 4-7.

Table 4-7

Response Examples to the Open-Ended Question regarding the Usefulness of the Collaboration Guides

Answers from Class A
-Facilitated collaboration helps to steer the conversation for collaboration in the right direction. -The convenience of facilitated collaboration made it easier to collaborate and helped us to work with each other and other groups to know what to do. -The project was a great use of technology.
Answers from Classes B and C
-It aided in properly collaborating. -It helped guide direction in what we were supposed to do. -We knew just what to do! -Straight to the point, detailed. -They were helpful for guidance. -I don't think we would have known what was going on without them. -The collaboration guides strongly effected collaboration. -Guidelines helps students do exactly what is needed for an assignment and prevents error and confusion. -I liked how we got freedom to create and collaborate in a way that works best for us. -Working in groups allowed us to thoroughly understand our project. I believe this is why we were able to create such a great Genius Project! -Collaboration within my group helped me learn so much more. -The TGP was super interactive and collaborative. It was very good / useful.

The responses indicated that the collaboration guides facilitated participants' collaborative learning by guiding ("… collaboration in the right direction") and helping them collaborate effectively ("….in a way that works best for us"). As shown in the data from group interviews and responses from the post-survey, participants found the collaboration guides useful. I also explored the usefulness of question prompts, digital literacy resources, and popular-culture resources. Not all the participants answered the open-ended question (Q 20), but as Table 4-8 shows, all the submitted responses (17 responses among 61) to the open-ended question except two indicated that the scaffolds were useful or helpful. However, there were two responses that indicated that the TGP and question prompts need to provide more clear and relevant guidance.

Table 4-8

Response Examples to Open-Ended Question Regarding Scaffolds

Students' responses from Class A
All the literacy resources were very useful in improving my general literacy. Guiding questions were very helpful. **All of these showed me real world examples of how digital literacy can be seen even when we don't notice or expect it.**
Students' responses from Classes B and C
I wish we had a guideline for where to begin. *Some of the questions I felt weren't directed towards what we are learning in class* The resources and guiding questions were vey helpful! Good examples were provided to help answer project's questions. These resources were all extremely useful. The guiding questions really helped us to keep moving along. The resources provided were very helpful with improving my digital literacy. These resources help guide my digital literacy **Videos and songs were cool to watch because I had seen some of them before but never thought about them in that way.** **Using popular culture was helpful with connecting to the source material** **I liked the pop culture references** **Connects our lessons to the real world**

Note. The responses that present suggestions are in italic and ones related to popular-culture resources are in bold.

As shown in Table 4-8, except for two responses that presented suggestions, the responses indicated that digital literacy resources, guiding questions, and popular-culture resources were useful for learning digital literacies ("These resources were all extremely useful."). In addition to participants' general satisfaction with multiple scaffolds, it was noticeable that participants enjoyed collaborative work during the TGP, as shown in the following section.

Theme 2. Learning from Each Other through Collaboration

Data from group interviews and participant responses to the open-ended questions (Q 17 and 18) indicated that they felt positive about their collaborative learning experiences during the TGP.

Observation. Collaborative learning activities during the TGP occurred from phase 2 to phase 9. Table 4-9 shows the observed moments of participants' collaboration in Classes A, B, and C.

Table 4-9

Observed Aspects and Moments of Collaborative Learning during the TGP

Phases	Topics	Observed Aspects and Moments of Collaborative Learning
1	Introduction	Antonio and I set the collaborative learning environments by inviting students to each class Google Drive, grouping students, and guiding them in how to use the TGP webpages and other resources.
2 to 7	- IKB - CKB, - Tech Force/Model Lesson - Video commercial design - Lesson plan design	• **Challenges of collaborative learning across classes** - In phase 2, I was concerned about the aspects of collaboration in Class A because it seemed that collaboration was not as active as Classes B and C. - The collaboration in the digital citizenship group from Class A did not work well because of some students' disengagement. - A student from class C was noticeably disengaged by reading books which were not associated with the TGP. - Tardiness and absences in Class A were more frequent than those in Classes B and C. • **Aspects collaborative learning across classes**

		- The collaboration group from Class A was very active and lively. I noticed they actively discuss how to design their lesson plan. - At initial stages of the TGP, I thought the Class A problem-solving group did not collaborate with each other because they worked so quietly. However, I found out that they sometimes discussed in a quiet manner and cooperated with each other by distributing the workload to each other. As the TGP continued, I was impressed by their concentration on the work and the quality of their work. - Students from Class B were calm and focused on their work. On the other hand, students from Class C were lively, but less focused. Therefore, I had to walk around more in Class C to guide their collaborative learning than I did for Class B. - I noticed that a group in Class C was cooperating by distributing guiding questions to each group member. • **Learning in discussion in groups** - The problem-solving group from Class A also discussed actively when they created their lesson plan. - While the collaboration group from Class A were working on Google Docs worksheet, they were actively talking about the description section of the lesson plan. I was impressed by the dynamics of collaboration. A similar collaboration was taking place in Class A's problem-solving group. - The students' discussion in Class B was very active
8	Video Commercials Creation	Collaboration was displayed in their created videos because in most groups' video commercials, they were playing unique acting roles.
9	Webpage design and publishing	Students from Classes A, B, and C were very busy with designing the webpages together using the content from their Google Docs worksheet.
10	Presentation	Students presented their collaborative work to their classmates.

Participants built their digital literacies in the processes of co-creating the explanation sections, video commercials for their chosen tools, and lesson plans. As shown in Table 4-9, the aspects of collaboration were different across classes and groups. For example, while the collaboration group from Class A was very talkative, active, and dynamic in their collaborating, the problem-solving group from the same class was calm and attentive in their collaboration. Both groups were observed to be highly engaged. In Class B, all groups showed high engagement in their collaborative work and there was little distraction. However, groups from

Class C were less attentive to their work in general than those from Class B, although they were very lively and dynamic. The liveliness of some groups in Class C sometimes led to a lack of attention, and I found myself giving more direct guidance in Class C.

It seemed that collaborative knowledge building processes were a combination of exploration, collaboration, cooperation, silent work, discussion, and distractions such as online private chatting, social media postings, and casual conversations with group members about diverse topics. Some participants from Class A appeared to be distracted by such behaviors as listening to music and watching YouTube videos irrelevant to class topics. In addition, absent and tardy participants from Class A degraded the quality of the collaborative learning. However, some groups from Class A such as the collaboration group and the problem-solving group showed high engagement and were less distracted. Participants from Class B were the least distracted, and participants from Class C were more distracted than those from Class B.

As shown in Table 4-9, even though participants showed different aspects of collaborative work, participants had the opportunity learn from each other through within-group collaboration and between-group collaboration.

One of these opportunities to learn from each other was group presentations. I felt that students needed more time in presenting their work because most groups exceeded the 7-minute limit on presentations. Hence, the experience of learning from one another was degraded by the lack of time allotted to presentations.

The following section shows group interview data on learning from other students in the TGP.

Participants' learning from each other in Class A. Interactions with within- and between-group classmates, which the TGP pursued facilitating, offered them opportunities for learning from each other. I interviewed two relatively highly engaged groups from Class A. The group interviews revealed that they enjoyed the collaboration processes. For example, Amelia from the collaboration group of Class A said, "…we had a good group and we all put in effort. So, it was a really good experience." In addition, Emma from the same group stated, "We learned how to use like different apps like worked with their certain project. So, learned how to use a lot of different apps that can help us with different uses of technology." Emma's response indicated that participants learned from each other in the process of between-group interactions.

In addition, group interviews with participants from Class A revealed that they gained knowledge of diverse tools from other students. For example, Baker (A) stated:

> I think this is the sort of first time to use like different kind of tools for I usually just, in the past I just present some group project like, with group member, but this class, uh, give us more variety of options to work how to collaborate with others and then how to use different tools, and I could learn a lot like, like CodeMonkey. I haven't heard about it at all, and this is very interesting to talk about and, I also could know from other groups' topics. I think it was very helpful.

Baker indicated that he learned diverse tools such as CodeMonkey from other students and groups. He revealed that working with his group members and students from other groups gave him opportunities to use different tools and learn diverse digital literacies. Similarly, Andrea (A) stated:

> I obviously learned a lot about what they had to teach us when they got up and did their presentations and through each of their things because they had spent all those weeks working on it and we had to kind of focus more on ours. Mmm, the constructive feedback was kind of cool to go back and like read their work and comment on it as it goes. So, when they did finally present, you could see like the things they added kind of how they had progressed through what they had learned and how like we could've how we helped them with our comments to like address things that they might not have thought to and so, I think it helped everyone kind of give a more well-rounded presentation at the end, especially that constructive feedback.

Andrea pointed out that each group of students put their efforts into their work, and each group learned from other students by viewing other group's work and receiving feedback from other students. This indicated that her group worked together to build its collective knowledge regarding its digital literacy practice(s). In addition, she also revealed that the between-group collaboration design of the TGP offered her opportunities to learn other digital literacy practices and tools from different groups.

The group interviews with participants from Classes B and C indicated similar findings as shown in the following section.

Participants' learning from each other in Classes B and C. Interview participants from Classes B and C also indicated that they learned from other students while enjoying working together. They especially enjoyed creating video commercials for their chosen tools. For example, regarding his experiences in creating video commercials, Evan (C) said, "Yeah it was really fun we liked it was interesting like coming up with the idea and then actually going through with it…" In addition, regarding their learning experiences with collaborative work, Jane and Sophia (B) responded as follows:

> **Jane**: I think like, looking at their commercials and stuff like, I just didn't thought [sic] about that way, but I like learned like, "Oh, that could be like one of the ideas." I learned like other creative things, ideas from them.
> **Sophia**: With their lesson plans we were able to learn like how you could do apply this to like K through 12 students, and like when like for example whenever we're like teachers in the future, we're able to use these types of strategies and etc in our classrooms.

Jane and Sophia also shared their experiences in learning from each other by looking at other students' video commercials for their chosen tools or lesson plans. Jane indicated that she formed a new perspective by watching other groups' video commercials. Sophia revealed she gained pedagogical knowledge of teaching K-12 students from other groups' lesson plans. Jane and Sophia indicated that social learning in the TGP was occurring. In addition, regarding their learning experiences from other students' work, James and Nadin (B) responded as follows:

> **James**: About different tools.
> **Nadin**: Hmm, I guess I just learned kind of how to connect the tools with the learning style like if it was like communication or if it was like digital citizenship like. I kind of like there are some tools that I was familiar with, but I didn't I never thought about how related back to that specific topic. So, kind of helping me like you know relate like what topics went with what kind of subject.

Similar to most of the other interview participants, James mentioned that he gained knowledge of different tools from other students. This indicated that the design of collaborative learning in the TGP exposed participants to the diversity of available tools rather than focusing on specific tools that are popular at a given time. In addition, Nadin indicated that she learned different digital literacy practices from other groups by realizing how to connect digital tools with different digital literacy practices. Similarly, Anne (B) also said, "…I liked was how the digital citizenship people included the BrainPOP page I don't know, I feel like that would be really useful in the future because it's very kid-friendly Web site." She also revealed that she learned a new tool from another group and had the idea of using it for teaching. Finally, Rachel and Chris (C) indicated their positive experiences with collaborative learning in the TGP by responding as follows:

> **Rachel**: Mmm, collaboration, working together makes things like you get to bring in ideas other people's opinions thoughts like even the thought process like you get to work together and just like create this one big idea, and like you don't always have to agree, but it's just a better way of bringing people together.
> **Chris**: And then, we can even see the more, the more people you collaborate with the better things become because even in our group we were able to do a great project but with the feedback from everybody else we improved upon what was already like a great project.

Rachel revealed that she had a positive perspective toward collaborative learning and held the belief that collaborative learning brings better ideas. Similarly, Chris indicated that their group created a better project by receiving feedback from other students. Chris's comment indicated that between-group collaboration was in effect along with within-group collaboration.

The design of the TGP pursued facilitating students' collaborative learning rather than cooperative learning. Although it was difficult to distinguish collaborative learning from cooperative learning in group work, the findings from group interviews indicated that participant groups had two different strategies for their collaborative knowledge building: mainly adopting a collaboration strategy and combining cooperation and collaboration, as shown in following section.

Participants' collaboration strategies. I asked participants from Classes A, B, and C how they worked together to build their collective knowledge. Some participant groups indicated that they worked together without dividing the work. For example, Emma and Amelia (A) responded as follows:

> **Emma**: We kind of all worked together on answering questions and just formed one solid answer if like what each of us thought needed to be in the answer.
> **…**
> **Amelia**: We, we had like one person typing most of the time whether it was one of the three of us, but um we would like say what we thought, and then somebody else would add to it, and so, it was just all of our ideas put together.
> **I: Uh-huh, so you have not divided you know distributed each question to another student the kind of stuff?**
> **Amelia**: No. We just worked together.
> **…**
> **Amelia**: I think we just thought that it was better to have all of our ideas because we each of us had a good idea _
> **Emma**: Yeah.
> **Amelia**: _but like putting it together was a really good point.
> **Emma**: Yeah. We were like on the same page and what we wanted to get across and like the rest of the project. So, we all worked together on the same ideas.

Emma and Amelia indicated that they mainly collaborated rather than cooperated. Even though the collaborative knowledge building activities could easily have been finished by distributing each question to each member, they chose to work on each question at the same time. Amelia indicated that their group thought that they could produce better results by collaborating. Because the TGP was designed to facilitate learners' collaborative learning, their aspects of collaboration were an ideal learning mode for the TGP. Similarly, the research group from Class B adopted mainly collaboration strategies rather than cooperation strategies. For example, regarding the aspects of working together, Bella, Anne, and Sophia (B) responded as follows:

> **Bella**: We each just kind of like added off each other.
> **Anne**: Yeah, I feel like we all kind of contributed to one answer because we were all looking at it at the same time we'd be like oh that doesn't sound good. Let's fix it, and somebody would type it, and we kind of did that on all the questions I think.
> **Sophia**: We would just read it out loud, and then I know we would just be like "What do you think?" We'd ask each other like "What do you think? This sounds good? or What do we should we change about it."

Bella, Anne, and, Sophia indicated that they mainly collaborated without distributing each question to each member. The Google Docs worksheet allowed them to work on each question at the same time. They shared their opinions about their collective knowledge with each other and updated the content based on their thoughts. This indicated that each member contributed to their group's responses to each guiding question.

However, some participants indicated that they built their collective knowledge by combining cooperation and collaboration, as shown in the following section.

The combination of cooperation and collaboration. Some participant groups from Classes A, B, and C chose to distribute each question to group members. However, they shared their opinions about their responses and updated their responses together. For example, regarding answering the guiding questions, Andrea and Amanda (A) responded as follows:

> **Andrea**: I think we split them up. Didn't we?
> **Amanda**: We split them up
> **Andrea**: We divided them between us. We all collaborated to come up with our own question because we wanted to like make sure that we all agreed on what we were answering or coming up with, but then after that I think we each took a question or two and answered it, and then everyone went back through everyone's work and just like read through it.

Andrea and Amanda revealed that they distributed the guiding questions and then collaborated on deciding on their own investigation question. Andrea also indicated that they reviewed each other's work. This can be viewed as a strategy of working together to accomplish their goal. Even though they clearly divided work between members, collaboration occurred when members reviewed one another's work. Evan (C) also adopted similar strategies:

> **I: So, after splitting up the work what did you do?**
> **Evan**: So, after we completed our each our sections we put it all together, and all of us reviewed all like everything what everything wrote, what everyone wrote to make sure everything was right, and everything just like flow together.

Evan indicated that their group also combined cooperation and collaboration modes when his group worked together. Even though his group distributed work to each member, they contributed to the group's collective knowledge by reviewing each other's work. Therefore, the group interviews indicated that the culminating product of the TGP—webpages, video commercials for their chosen tools, and lesson plans—was created by a combination of students' collaboration and cooperation.

The interviews with participants revealed that participants learned from each other by working together in collaboration and cooperation. In addition to the group interviews with participants, respondents' answers to the open-ended question indicated participants in general learned digital literacies through collaborative work during the TGP as shown in the following section.

Responses to the open-ended questions regarding collaborative activities. Seventeen participants among 61 answered the open-ended question (Q 17) on the post-survey regarding collaborative activities during the TGP. In addition, 23 students among 61 students responded to the open-ended question (Q 18) on the pre-survey regarding aspects of collaboration. As shown in Table 4-10, except for two responses from Class A and one response from Class B, the submitted responses mostly indicated that they found the collaborative activities helpful ("All of these things helped me learn at a deeper level") for learning digital literacies and enjoyed working with other students ("I truly enjoyed working with my team"). The two responses from Class A indicated that some group members from Class A did not effectively contribute to the teamwork, and some students in Class A communicated with their group members after class to finish the project. Finally, one response from Class B stated that it was difficult for 20 students to work on one Google Docs worksheet at the same time because the Google Docs worksheet kept scrolling as students edited the worksheet in various locations within the worksheet. This indicated the need to prepare a Google Docs worksheet per group instead of per class.

Table 4-10

Response Examples to the Open-Ended Questions Regarding Collaborative Activities

Answers from Class A
-*Not all of our group was present/contributed to every section* -*Although myself and both of my team members had trouble getting here, we always communicated through SMS to make sure we didn't get too far behind* -I think they really helped. It became easier for groups to interact and to gain constructive feedback -All of these activities were very helpful for improving digital literacy but some were better than others because they they incorporate working with others a little more heavily -Overall, I was very satisfied with the collaboration of my group
Answers from Classes B and C
-*Having people working on a Google Doc at one time was hard because the page kept moving up and down.* -I loved working for this project -I enjoyed learning from my classmates -All of these things helped me learn at a deeper level. -I hadn't learned how to Google Docs or creating a website before this class -Working on a team allowed us to help each other understand what we were missing. -I truly gained insight from creating the infomercial video -I really liked working with my group -Everything that is collaborative is very helpful in improving digital literacy -> anything helps! -I enjoyed being able to collaborate with my classmates about all of our projects. -I liked working in groups to create a Web site. -My group worked very well together, and each person had an effective contribution. -Collaboration was very good during the project.

-I truly enjoyed working with my team. -Working as a group brings more knowledge and ideas. -Working as a group can help you better your skills

Note. The neutral and negative responses and responses that present suggestions are in italic.

As shown in Table 4-10, the responses from the post-survey mostly indicated that the TGP provided participants with opportunities to learn from each other. Therefore, the data from the group interviews and participants' responses to the open-ended question revealed that participants generally enjoyed working with other students and learned digital literacies during collaborative learning processes. In addition, participants found peer feedback activities useful in general, as shown in the following section.

Theme 3: Usefulness of the Feedback Activities

The between-group collaboration was implemented through the feedback activities. Collaboration guides, which structuralized the feedback activities, provided guidance for feedback. Participants followed the phases and procedures of the feedback activities, which were explained on the TGP web pages. Each group had its own number. As mentioned in an earlier section, to determine the group to receive feedback, the group providing feedback added +1, +2, +3, +4, or +5, depending on the week, to its own group number. Some participants were confused about this instruction, but when the instructors explained the method through examples, they understood what it meant.

According to the rubric, students were supposed to leave 20 constructive feedback comments on other groups' work in total with ideas for making their work better. However, the feedback comments were a mixture of complimentary remarks such as "…great…," "…cool…," and "I like…" along with constructive feedback. The constructive feedback seemed useful because it gave suggestions for improving the work. In general, participants engaged well in giving feedback to other groups. However, it seemed that the rubric requirement which specified the minimum number (20) of feedback comments contributed to the complimentary feedback comments. I thought these design problems demonstrated the importance of adequate collaboration guidance.

The data from group interviews and participants' responses to the open-ended questions (Q 17 and 18) on the post-survey indicated that participants found the peer feedback activities useful, but some participants thought that the amount of required feedback was too much, which should be modified in the next implementation.

Group interviews with participants from Class A. I investigated participants' experiences with feedback activities. Interview participants from Class A thought the peer feedback activity useful. For example, regarding giving feedback on other groups' work, Amanda and Baker (A) responded as follows:

> **Amanda**: I mean it helped that there was like kind of a rubric to follow. Especially like for each individual group because every group had a different question to answer. Mmm, so it just kind of went off of that, but also like, we just kind of like, we're looking for like things we would want to change in like our personal assignment. So, that helped a little bit like, "Okay, like we will want to see like XYZ in our assignment, but they don't have that here and they need it." So that kind of helped.
> **Baker**: I think also I could know their opinion like we look at this, in this point of view, but others can have different point of view. So, I could learn from them like, "I didn't think about this way." Then they comment this way, so like we can fix it, and we can improve more our products. So, it was great.

Amanda said that the activity of giving feedback was useful because other groups could check if their work was following the rubric. Baker thought that he could form a different perspective from other groups' work, and his group improved their work based on other students' feedback. The feedback contributed to improving the quality of the final work. Amanda and Baker indicated that the feedback activity served the purpose of learning from other groups and facilitated collaborative learning between groups. Regarding receiving feedback from other students, Emma and Amelia (A) responded as follows:

> **Emma**: I think it was really helpful to get like another perspective and, like, and things that we had missed over but didn't realize, and so they looked at the rubric and saw that we had missed that. So, it was really helpful that way to know what to do.
> **I: Yes, and have you reflected other students' feedback to your work?**
> **Amelia**: Mmhmm, we did, we... I think one of them was I don't think we had enough words to meet the word-count requirement, and so I think we went back and added some more, and I think for a few things we just had to explain further like the…
> **Emma**: Yeah, sometimes they were kind of confused on our answers or something, and so we rephrase it to help them understand it better.

Both Emma and Amelia thought that receiving feedback was helpful because it gave them a different perspective or helped them find what was missing in their work. Emma and Amelia indicated that the feedback activity contributed to improving their group's work. Participants from B and C also found the feedback activity helpful as shown in the following section.

Group interviews with participants from Classes B and C. Students from Classes B and C engaged in almost the same feedback activity as that of Class A. They also thought the feedback activity was helpful. In addition, regarding receiving feedback from other students, Bella and Sophia (B) responded as follows:

> **Bella**: I feel like it was very helpful because that would be like an example or like something like to further explain like your stuff, so like instead of just giving you facts like it go into more detail and something like helped us a lot.
> **Sophia**: And like Anne said, oh, sorry, said her name, but like she said about how if you would have like left something out, they were able to tell you like, "Hey, you forgot to do this," and then you could be like "Oh yeah, I did forget to do that," and then you could fix it.

Both Bella and Sophia thought that receiving feedback was helpful because it contributed to improving their work. For example, Sophia mentioned other students reminded them if their work missed any requirements. In addition, regarding giving feedback on other group's work, Rachel, Chelsea, and Chris (C) stated:

Rachel: Um, I definitely learned that feedback doesn't always have to be negative or like there's good feedback how we discussed like saying it was we like how you embedded links and stuff, but so it's like constructive criticism as well like you could go both ways.
Chelsea: And we could give suggestions on like what we think or like stuff they can add, seeing it from a different perspective, and um, you could always like talk about it with your group about what we should say or what we think of it.
Chris: Yeah, I think that um giving the feedback was just, it made for a better Web site altogether for everybody. I think it was a great thing for us to do.

Rachel mentioned that she learned how to give constructive feedback, and Chelsea pointed out that giving feedback was like helping people see the work from a different point of view. Finally, Chris said that giving feedback helped create a better class Web site. However, some students thought that the feedback activity needed improvement because some feedback from other students was not meaningful. For example, regarding their experiences in receiving feedback, Evan and Odin (C) responded as follows:

Evan: Ah, sometimes it was very good, it was very constructive. Sometimes it was like I don't think so. Like when they said something like, I don't know about that.
All: Ha ha ha
Odin: It’s good to see different perspectives at the same time. There were some things that were kind opinion-based, so those like, it depends, you know, how strong their opinion is, but sometimes I just feel that yours is the right way to go sometimes.

Evan indicated that the feedback comments were the combinations of helpful ones and less meaningful ones because he thought that some students left comments without knowing their topic well. However, Odin indicated that the feedback activity gave him the opportunity see different perspectives on their work. Similarly, Nadin and James (B) responded as follows:

Nadin: Yeah, there was definitely, there's some useful feedback like the constructive criticism and stuff, but yeah, like James said, they were a lot of just like oh, you know “I like this idea” or “cool,” stuff like that. So, I mean that's nice to hear, but it doesn't really help us. So, there were like a few in there that were, you know, constructive at the same time like if you know like the people again like aren't familiar with like what you're doing, and you don't want to like make changes automatically just cuz like you know someone says something if like you're more familiar with the tool, then they might be sometimes people like don't understand like what you're doing. So, it's hard to just like go take the criticism and just change everything you did because somebody might have said something. So, it's kind of you kinda have to evaluate what is like necessary to change.

> **James**: Some other people had some good comments. I, I don't know how much you could do it better, it's a good system as far as feedback—1 plus, 2 plus groups—but yeah, it's just someone's feedback wasn't helpful at all, which, which, I mean isn't terrible. I mean we already had plenty to work on honestly if, if, if everybody had given really constructive feedback, and we had to get through and resolve all of that. I don't know how many people commented on each thing or not or on ours, but it would have been a lot of things we had to fix.

Nadin and James pointed out that feedback comments were a mixture of constructive and complimentary feedback. They indicated that the complimentary feedback was not helpful because it merely stated that their project was "cool" without offering suggestions to make their work better. Nadin also described how her group reflected other students' feedback to her groups' work in detail. She indicated that some students did not understand what her group was trying to achieve. She revealed that the feedback which resulted from other students' misunderstanding was not helpful for modifying her group's work. In the next section, I present examples of constructive feedback and of less helpful feedback from participants' comments on other groups' work.

Participants' feedback and responses to the open-ended questions. As mentioned earlier, the feedback was a mixture of constructive feedback and complimentary comments. For example, participants from Class A left comments on the communication group's explanation section as follows:

> **Stella:** Outside of the guiding questions, the rubric calls for an additional question that your group comes up with and answers, so be sure to add that!
> **Kabira:** To meet the word count and be more descriptive. Maybe, add more benefits to using technology for communication.
> **Daniela:** Overall, I think these questions are answered really well! Be sure to embed pictures and videos if you haven't planned to already.

This kind of feedback was constructive because it could be helpful for other groups to improve their work based on the suggestions. However, complimentary feedback merely stated that the reviewer liked certain parts. For example, Madelyn (A) left comments on the creating and publishing group's work as follows:

> I love how Google Docs lets anyone edit and add to any project. That's a great attribute. I like how you can also keep work private or public.

Madelyn's feedback may have been encouraging, but it was not constructive for the creating/publishing group. Similarly, participants from Classes B and C displayed how they provided their feedback, which was a combination of constructive feedback and complimentary comments. For example, participants from Classes B and C left constructive feedback as follows:

> **Dana (B):** I think these are great research tools, but I suggest explaining what each site allows the students to do when conducting research.
> **Kaily (B):** Maybe explain a little more about what Web 1.0 and 2.0 are and what they allow people to do. Like their functions and benefits of using it.
> **Molly (C):** Again, give some more details about the functions of the tool. for example, YouTube's only function is not videography, so give some more features it is good for.
> **Aaron (C):** Could you clarify what digital literacy skill that is being employed when you use YouTube?

The feedback examples above provided ideas or suggestions for improving other groups' work. Therefore, it was more aligned with the purpose of the feedback activity, which was to improve the quality of published Web site content. However, other feedback lacked ideas or suggestions for making the collaborative work better. For example, some participant feedback from Classes B and C only offered complimentary remarks on another group's work as follows:

> **Brooklynn (B):** These are two great real-world examples!
> **Cecilia (C):** This is a very good description of using communication with tech.

It is difficult to say the feedback was bad, but it was not meaningful for collaboration because the contribution to improving the final work was limited. Therefore, these comments were not as useful as constructive feedback to another group.

Regarding the open-ended questions (Q 17 and 18) about the collaborative activities and aspects of collaboration during the TGP, participant responses indicated the necessity of improving the design of the feedback activity, as shown in Table 4-11.

Table 4-11

Students' Responses to the Open-Ended Question regarding Feedback

Students' responses from Classes B and C
I find the feedback very helpful
I liked giving and receiving feedback from / to classmates
I find the feedback very helpful.
Some feedback helped a lot, and with others, **you could tell people send whatever to meet the rubric requirement, so those comments were distracting**.
Sometimes the feedback from classmates was not very helpful
People just gave feedback about anything. It wasn't always helpful

Note. Negative responses are in bold.

So far through the current theme, the data indicated the useful aspects of the feedback activity, but as indicated in Table 4-11, the feedback activity requires a design change because there were feedback comments that were not meaningful and merely complimentary, at least in part due to the rubric requirement.

In this chapter, I presented the results and findings regarding the second research question: the roles of multiple scaffolds. The results and findings revealed participants' perceptions of and experiences with collaborative learning during the TGP and the supporting role of multiple scaffolds for their collaborative learning or digital literacy learning. In the next chapter, I present my interpretations with regard to the results and findings.

CHAPTER 5

RESULTS AND FINDINGS: DIGITAL LITERACY DEVELOPMENT

In this chapter, I present the results and findings of this study regarding the second research question that was investigated: *What digital literacies are reflected in the Technology Genius Project developed in an undergraduate technology integration course?*

I describe the results and findings of this study from three classes: one class led by Antonio (Class A) and two classes (Classes B and C) taught by me. The duration and frequency of Antonio's class and my classes were different. Although the majority of activities were the same, there were variations in the sequence of activities between Antonio's class and mine. Due to these variations, I present the results and findings separately.

The results from quantitative data indicated that participants from all the classes experienced statistically significant growth in confidence in helping others implement digital literacy practices and positive attitudes toward teaching digital literacy education. The findings from qualitative data indicated that participants from all the classes experienced growth in digital literacy competency in terms of digital literacy knowledge and skills. I describe the results and findings based on quantitative data and qualitative data below.

Quantitative Results

I investigated participants' digital literacy development and the change in their attitudes toward digital literacy education through the pre- and post-surveys. I present the results in the following sub-sections.

Digital Literacies in Class A

I analyzed the changes in participants' perceptions regarding their confidence level in helping others implement digital literacy practices. The nonparametric Wilcoxon Signed-Rank test was conducted to compare mean differences between the pre- and post-surveys on research participants' digital literacy development from Class A because of the small sample size (Russell, 2018). As Table 5-1 indicates, there were statistically significant increases in digital literacies, which comprise six digital literacy practice variables (Z = −2.596, p = 0.009, r = −0.41).

Table 5-1

Analysis Result of Digital Literacy Education Confidence for Class A

	Pre-survey (n = 20)		Post-survey (n = 20)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Confidence in digital literacy education	5.420	1.592	6.520	1.636	−2.596	**.009**	−.41

Note. Significant positive effects are in bold.
Scores can range from 1 to 10.

Across the six digital literacy practice variables, as shown in Table 5-2, there were statistically significant increases in two of six variables including: digital literacy (Z = −2.730, p = 0.006, r = −0.431) and research (Z = −2.309, p = 0.021, r = −0.365).

Table 5-2

Analysis Result of Digital Literacy Education Confidence across Digital Literacy Practices for Class A

	Pre-survey (n = 20)		Post-survey (n = 20)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Social interaction	6.175	1.498	7.050	1.805	–1.638	.101	–.258
Creating	5.050	2.502	5.850	2.158	–1.518	.129	–.240
Publishing	5.600	3.101	5.950	2.211	–0.644	.520	–.101
Digital citizenship	5.800	2.647	7.900	1.483	–2.730	**.006**	–.431
Research	5.200	2.483	6.650	1.663	–2.309	**.021**	–.365
Problem solving	4.700	2.105	5.725	2.285	–1.839	.066	–.290

Note. Significant positive effects are in bold.
Scores can range from 1 to 10

Digital Literacies in Classes B and C

A paired samples *t*-test was conducted to compare the pre- and post-surveys on research participants' digital literacy level regarding confidence in helping others implementing digital literacy practices from Classes B and C (Russell, 2018). One student's data from Class B was excluded because of incomplete responses. In addition, one student's data from Class C was excluded because the student submitted the pre-survey in the middle of the TGP. The Shapiro-Wilk test was conducted to test normal distribution of data as a requirement for the paired-samples *t*-test. The paired differences of all variables met the normality assumption. As Table 5-3 indicates, participants' level of digital literacies ($t = 8.493$, $p < 0.001$, $r = 0.33$) from Classes B and C significantly increased.

Table 5-3

Analysis Result of Digital Literacy Education Confidence for Classes B and C

	Pre-survey (n = 39)		Post-survey (n = 39)				
	Result of Paired Samples t-test						
	M	*SD*	*M*	*SD*	*t*	*p*	*r*
Digital Literacies	5.532	1.851	8.119	1.388	8.493	**< .001**	.33

Note. Significant positive effects are in bold.
Scores can range from 1 to 10.

Specifically, as Table 5-4 presents, there were statistically significant increases in all the variables: social interaction ($t = 5.699$, $p < 0.001$, $r = 0.19$), creating ($t = 4.751$, $p < 0.001$, $r = 0.12$), publishing ($t = 7.032$, $p < 0.001$, $r = 0.37$), digital citizenship ($t = 10.240$, $p < 0.001$, $r = 0.47$), research ($t = 5.226$, $p < 0.001$, $r = 0.12$), and problem solving ($t = 5.952$, $p < 0.001$, $r = 0.32$).

Table 5-4

Analysis Result of Digital Literacy Education Confidence across Digital Literacy Practices for Classes B and C

	Pre-survey (n = 39)		Post-survey (n = 39)				
	Result of Paired Samples t-test						
	M	*SD*	*M*	*SD*	*t*	*p*	*r*
Social interaction	6.435	1.954	8.435	1.447	5.699	**< .001**	.19
Creating	5.359	2.497	7.641	2.006	4.751	**< .001**	.12
Publishing	5.000	2.615	7.897	1.832	7.032	**< .001**	.37
Digital citizenship	5.282	2.645	9.128	.978	10.240	**< .001**	.47
Research	5.821	2.024	8.000	1.905	5.226	**< .001**	.12
Problem solving	5.294	2.276	7.615	1.879	5.952	**< .001**	.32

Note. Significant positive effects are in bold.
Scores can range from 1 to 10.

Digital Literacy Attitudes in Class A

The nonparametric Wilcoxon Signed-Rank test was conducted to compare Class A participants' mean scores between the pre- and post- surveys regarding attitudes toward digital literacy education in K-12 schools because of the small sample size (Russell, 2018). I investigated the participants' attitudes regarding five instead of six digital literacy practices by mistakenly not including a variable—attitudes toward the *research* digital literacy practice—in the surveys. As shown in Table 5-5, results indicated Class A participants had statistically significant growth in their attitudes toward digital literacy education in K-12 schools (Z = –2.719, p = 0.007, r = –0.42).

Table 5-5

The Analysis Result of Attitudes toward Digital Literacy Education for Class A

	Pre-survey (N = 20)		Post-survey (N = 20)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Digital Literacy Attitudes	4.055	0.801	4.395	0.711	–2.719	.007	–.42

Note. Scores can range from 1 to 5.

In terms of the digital literacy practice variables, as shown in Table 5-6, there were statistically significant increases in two variables: publishing (Z = –1.998, p = 0.046, r = –0.31) and digital citizenship (Z = –2.066, p = 0.039, r = –0.32).

Table 5-6

The Analysis Result of Attitudes toward Digital Literacy Education across Digital Literacy Practices for Class A

	Pre-survey (n = 20)		Post-survey (n = 20)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Social interaction	4.275	.895	4.575	.568	−1.951	.051	−.30
Creating	3.900	.967	4.100	.967	−0.921	.357	−.14
Publishing	3.750	1.292	4.200	1.005	−1.998	**.046**	−.31
Digital citizenship	4.150	.988	4.650	.670	−2.066	**.039**	−.32
Problem solving	4.200	.833	4.450	1.099	−1.184	.236	−.18

Note. Significant positive effects are in bold.
Scores can range from 1 to 5.

Digital Literacy Attitudes in Classes B and C

I compared the mean differences between the pre- and post-surveys on research participants' attitudes from Classes B and C regarding digital literacy education in K-12 education. As mentioned earlier, a variable—attitudes toward the *research* digital literacy practice—was mistakenly not included on the surveys. Normal distribution of the data was tested by the Shapiro-Wilk test. Digital literacy attitudes variable did not meet the normality assumption. Therefore, the nonparametric Wilcoxon Signed-Rank test was conducted. As shown in Table 5-7, there was statistically significant growth in participants' attitudes toward digital literacy education in K-12 schools (Z = –4.160, $p < 0.001$, $r = –0.47$).

Table 5-7

The Analysis Result of Attitudes toward Digital Literacy Education for Classes B and C

	Pre-survey (n = 39)		Post-survey (n = 39)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Digital Literacy Attitudes	4.276	0.775	4.779	0.413	–4.160	**< .001**	–.47

Note. Significant positive effects are in bold.
Scores can range from 1 to 5.

Specifically, as shown in Table 5-8, there were statistically significant increases in the scores of participant attitudes toward digital literacy education in K-12 schools from classes B and C in the following variables: social interaction (Z = –3.857, $p < 0.001$, $r = -0.43$), creating (Z = –3.309, $p = 0.001$, $r = -0.37$), publishing (Z = –3.420, $p = 0.001$, $r = -0.38$), digital citizenship (Z = –3.272, $p = 0.001$, $r = -0.37$), and problem solving (Z = –2.543, $p = 0.011$, $r = -0.28$).

Table 5-8

The Analysis Result of Attitudes toward Digital Literacy Education across Digital Literacy Practices for Classes B and C

	Pre-survey (n = 39)		Post-survey (n = 39)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Social interaction	4.384	.846	4.897	.365	–3.857	**< .001**	–.43
Creating	4.051	.944	4.641	.742	–3.309	**.001**	–.37
Publishing	3.974	1.038	4.538	.853	–3.420	**.001**	–.38
Digital citizenship	4.436	.852	4.949	.223	–3.272	**.001**	–.37
Problem solving	4.538	.822	4.872	.409	–2.543	**.011**	–.28

Note. Significant positive effects are in bold.
Scores can range from 1 to 5

Qualitative Findings

I explored participants' digital literacy development and their attitudes toward digital literacies. I present the findings in the section. First, at the beginning of the TGP, participants revealed positive attitudes toward learning more about digital literacies on the pre-survey open-ended question: digital literacy survey (Q 15). 59 participants responded to the open-ended question, and 55 students from Classes A, B, and C (n = 61) indicated that they were motivated toward learning more about digital literacies even though they had diverse backgrounds. Furthermore, some of the responses stressed the importance of learning digital literacy with regard to their future career and K-12 education. For example, the following responses from the pre-survey showed participants' motivation about pursuing learning digital literacies (note: pseudonym is followed by class designation in parentheses).

> **Kacee (A)**: I would like to learn more about digital literacy. I think it will help me with my future career. I would like to work with kids and incorporating technology is something that is important to me.
> **Kara (A)**: The world is evolving into being more technological. Therefore, it is ever important for students to understand how to use it.
> **Madilyn (B)**: I really want to learn more about digital literacy especially because it can help my students learn better in my classroom.
> **Jessica (B)**: I'd like to be more confident and comfortable using technology for learning and job purposes.
> **Jasmine (C)**: I think learning how to do all of this can help me in any job, so I really want to learn everything I can from this class.
> **John (C)**: Because I am going into business and the world is moving into more technological advancements, I need to grow into using more technology and understanding how to communicate with it.

Along with motivation toward learning more about digital literacies, on the pre-survey (Q 16), most of the participants (more than 50 %) from Classes A, B, and C had no concerns about developing more digital literacy knowledge and enhancing digital literacy skills. For example, Gina (B) said, "I don't have any concerns. One reason I wanted to take this class was to gain digital literacy and enhanced technological skills." However, there were participants who expressed their concerns about developing their digital literacy knowledge and skills as shown in Table 5-9. As the data indicated, at the beginning of the TGP, some participants had diverse concerns such as: understanding all the details about technology, depending too much on technology, not having enough knowledge and skills at the moment, and losing the importance of face-to-face interaction.

Table 5-9

Response Examples to an Open-Ended Question about Participants' Concerns on the Pre-Survey

Class A
- Just understanding the in and out of it all. - I don't know how to use a bunch of different kinds of technology, so I feel like I'm not the most proactive in digital literacy knowledge. - I don't want to rely on technology. Even though it is a great thing that can be beneficial, I think people need to know how to learn without it.
Classes B and C
- My only concern is people will forget the importance of face-to-face interactions and learning. - I worry maybe society will rely on technology too much to solve everything instead of using our own minds and solving in person. - People may lose face-to-face communication skills. - I am just concerned, due to my lack of knowledge that I will have a difficult time with the tasks.

Although there were participants who revealed their concerns about developing digital literacy knowledge and skills, a majority of students (93%) were motivated about learning digital literacies at the beginning of the TGP. Participants engaged in about 5 weeks of the TGP project, and, as shown in Table 5-10, four themes related to the first research question (digital literacy development) emerged from the field notes of my observations, individual and collaborative participant products, and interviews. The first theme was participants' growth in their digital literacy knowledge, which is shown in the next section.

Table 5-10

Themes Related to Digital Literacy Development

Themes	Data/Findings
Theme 1: Improved digital literacy knowledge	Field notes, participant individual and collective products, and interviews indicated that participants showed improved digital literacy knowledge.
Theme 2: Improved digital literacy skills and utilization of digital literacy skills	Field notes, participant individual and collective products, and interviews indicated that participants showed improved digital literacy skills and used the digital literacy skills they had to complete the TGP.
Theme 3: Improved knowledge regarding technology integration in education	Field notes, participant individual and collective products, and interviews indicated that participants showed improved knowledge regarding technology integration in education, but they need more understanding regarding meaningful integration of technology.
Theme 4: Positive attitudes toward digital literacies and enjoyment of the TGP	Participant individual products, responses to open-ended questions (Q 15 and 16) on the post-survey, and interviews indicated that participants generally had positive attitudes toward digital literacy education in K-12 school as well as digital literacy learning.

Theme 1: Improved Digital Literacy Knowledge

The data from the field notes, participant products, and interviews indicated participants' improved understanding of digital literacy practices.

Observation and participant products. The TGP was composed of 10 phases. Across the phases, participants gained knowledge regarding digital literacy practices. Table 5-11 presents examples of the observed moments of participants' digital knowledge building processes in Classes A, B, and C. It should be noted that Class A and Classes B and C were taught by Antonio and me, respectively. Therefore, before the TGP, students learned through different activities. However, prior to Phase 1: Introduction, students in Classes A, B, and C read Howland et al. (2012) as an assignment, which was expected to provide them with ideas about what *meaningful learning with technology* is.

Table 5-11

Observed Moments of Digital Literacy Knowledge Building during the TGP

*IKB = Individual knowledge building activities/CKB = Collaborative knowledge building activities

Phases	Topics	Observed Moments of Digital Literacy Knowledge Building
1	Introduction	• **Misunderstanding the goal of the TGP in Class A** - Antonio started the first TGP class by showing the Spacejam (www.spacejam.com) Web site, which showed what Web sites looked like thirty years ago. I thought Antonio did so to explain one of the TGP tasks, which was to create a class Web site. I thought that I needed to ask him to explain the social context of the TGP to his students, which was to share their digital literacy knowledge with educators around the world. - The social context of the TGP was explained to the students from Classes B and C.
2 to 7	- IKB - CKB, - Tech force/Model lesson - Video commercial design - Lesson plan design	• **Understanding the goal of the TGP** - Antonio explained the goal of the TGP by saying that the goal of the TGP was to create the class Web site for K-12 teachers. • **Learning digital literacy knowledge** - The problem-solving group (A) was working in a calm and focused manner. I wondered how they were collaborating with each other. When I approached their table, I noticed that they were conducting research on the *problem-solving* digital literacy practice. As my observation continued, I realized that the problem-solving group from Class A was working together very well. - The collaboration group from Class A was discussing the difference between collaboration and cooperation. - Students in class B actively engaged in creating explanation sections on their Google Docs worksheet. They searched Web sites to find the necessary information. For example, the creating and publishing group (B) searched Web sites to find the difference between Web 1.0 and 2.0. They found a resource from a Coursera online course which explained the difference between Web 1.0 and 2.0. - The problem-solving group (C) chose YouTube as a problem-solving tool, but I suggested focusing on design and computational thinking and showed them the resource pages. I also reminded them of Blockly and Ozobot, which they already knew about. Then, they realized what they were supposed to do. They decided to advertise Blockly and Ozobot in their video commercial. - Reading and reviewing other groups' work, students from Classes A, B, and C gave their feedback on other groups' work.

		- Students from Classes A, B, and C submitted six IKB assignments regarding six digital literacy practices. The submitted assignments indicated students' knowledge regarding digital literacy practices. • **Difficulties in collaborative knowledge building** - I was concerned about the problem-solving group (B) because their work did not reveal a clear understanding of design and computational thinking. I explained to the group about the concept of the design and computational thinking. I also introduced Microbit (micro computers) to them. They told me they would revise the whole document based on my suggestions. - In Class C, I felt that some students were having a difficult time connecting their video commercials to their group's digital literacy practice(s). For example, the communication group (C) chose the Kahoot interactive quiz platform as their chosen tool for their video commercial. They thought that Kahoot could be a good tool for communication because it related to communicating content knowledge. I said it was okay to choose the tool, but I told them that they needed to defend their position.
8	Video Commercials Creation	• **Independent work of creating and publishing videos** - Students created videos at the places their group chose. The created videos indicated students' knowledge regarding tools corresponding to their groups' digital literacy practice(s).
9	Webpage design and publishing	• **Designing and publishing webpages** - Students from Classes A, B, and C needed instructors' guidance and help regarding designing and publishing practices. For example, webpage design using images, font sizes, and layout feature was guided.
10	Presentation	• **Revealing their knowledge regarding their digital literacy knowledge** - The presentation in Class A took place over two class periods. Therefore, the instructor and students in Class A were less pressured regarding the presentation time despite the 7-minute time limit. The problem-solving group from Class A thoroughly explained what design and computational thinking was for about 10 minutes. They showed their video commercials regarding CodeMonkey. I thought other students learned about design and computational thinking through their presentation as well as CodeMonkey block programming tool. -Students from Classes B and C really wanted to present in detail. I felt bad when I had to require students to limit their presentation time. I realized that if I had given the students more time, the students could learn more from their presentations about digital literacy practices.

As shown in Table 5-11, the observed moments indicated that participants acquired digital literacy knowledge by understanding the goal of the TGP; researching and discussing their groups' digital literacy practices for collaborative knowledge building (CKB); gaining digital literacy knowledge through individual knowledge building (IKB) assignments; designing video commercial plans; and reading other groups' work in the process of giving feedback on other groups' work. Some participants from B and C had occasional difficulties in connecting their groups' digital literacy practices to the tools they advertised in the video commercials and understanding their group's digital literacy practices. However, except for these instances, they did not have much difficulty in co-constructing their digital literacy knowledge.

In the next section, I describe digital literacy knowledge shown in participants' individual knowledge building (IKB), which took place from phase 2 to phase 7 during the TGP.

Individual knowledge building (IKB) in Class A. Individual knowledge building (IKB) activities were designed to provide a base for collaborative knowledge building (CKB) activities. Participants indicated their knowledge of and thoughts about the six digital literacy practices through individual knowledge building (IKB) assignments. For example, Harry wrote:

> With Zoom, I could post videos of lessons to students. For class projects outside of class, students can use Skype and Google Hangouts to voice chat/video chat and communicate with other. ClassDojo can be used to assign homework and record attendance. I can post homework and project reminders in Remind and create a class GroupMe for communication outside of class. I can do a communication activity with GroupMe where students send group members their progress on a particular project.

Harry revealed his knowledge of *communication* digital literacy practices using diverse synchronous and asynchronous communication tools such as Zoom, Skype, Google Hangouts, ClassDojo, Remind, and GroupMe. This indicated that Harry had acquired the knowledge of implementing asynchronous and synchronous communication digital literacy practices. In addition, regarding *digital citizenship* digital literacy practices, Karen responded as follows:

> I think our present reality is somewhat similar to the *Black Mirror*, Season 1, "Nosedive." Many people are so focused on how others perceive them and what others "rate" them as. I think this is especially seen on social media. Nowadays, people post on social media and base their worthiness on the "likes" they receive. I think that "Nosedive" is a great representation of what our world is turning towards. Instead of focusing on good things in life, people are more focused on how people see them and "rate" them.

Karen is relating how people use social media to the plot of "Nosedive," Episode 1 from Season 3 of the drama *Black Mirror*, by mentioning negative aspects of using social media in relation to digital citizenship. Reflecting on the episode, she pointed out that social media sometimes distracts people from the true value of life. Her reflection on digital citizenship demonstrated her knowledge of the issue of establishing adequate digital citizenship on social media. Likewise, participants from Classes B and C displayed their knowledge of the six digital literacy practices as shown in the following section.

Individual knowledge building (IKB) in Classes B and C. As was the case with the participants from Class A, participants from Classes B and C also demonstrated their understanding of digital literacy practices. For example, regarding her favorite creation or publishing tools, Pacey from Class B wrote:

> I like the tools Wordpress.org and new Google Sites. I haven't really used these tools that much but have been using them recently in this class. We have started using new Google Sites, and I really like the format of them and how easy they are to use. I just started using them and have caught on really quickly. I also like Wordpress.org. I know a lot of students use this to write blogs because I have read a lot of blogs off Wordpress.org.

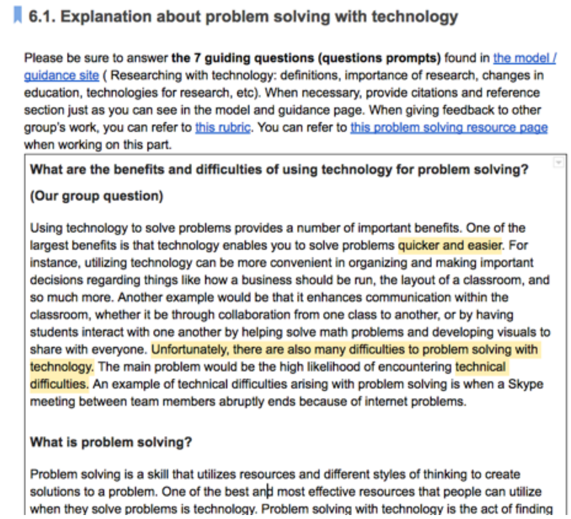
Pacey indicated her knowledge of Web site platforms such as new Google Sites and WordPress as a PHP platform, where people create and publish web content. Furthermore, she mentioned that she was learning how to use new Google Sites, which was being used as the TGP class Web site. In addition, regarding her favorite tools associated with *problem-solving* digital literacy practices, Gwen from Class C wrote:

> My two favorite sites for computational thinking and design thinking are Mural and MindMeister. These are my favorite sites because it allows for collaboration within the students to solve a problem. They have to come up with a design to fix the problem and then draw it out via these two design thinking sites. Not only is it useful for the student to be able to connect the events to each other, but for presentation purposes as well. What I like about Mural is that the students can draw and show their artistic side with the site. They can add color and watch their partners make edits. Art allows for students to explore a real-world problem and try to imagine how they would solve it. In addition to this site, MindMeister is something we used in class that I enjoyed. We came up with a common question, "what do you like about ***," and then we all stemmed our answers from other answers or came up with our own. Visually this looks like a graphic organizer and is beneficial for design thinking process because it shows the thinking patterns and can allow for the beginnings of a project to come about. As for computational thinking, my favorite site out of the below sites would be Khan Academy. For someone not exposed to coding prior to this class I find the tutorials beneficial for starting out on the right foot for my projects. Essentially, Khan Academy will take the student through a video that will break down the steps slowly, leading to better understanding. Students know about this site already through math or even science help, so it would allow for a sense of comfort for your students if you decide to use it in the classroom.

Gwen elaborated on her knowledge regarding *problem-solving* digital literacy practice by explaining how to use digital tools such as Mural and MindMeister for facilitating design thinking. She indicated she liked the visual aspects of Mural and MindMeister, which were introduced to students as a class activity during the TGP. She also revealed her knowledge of using Khan Academy online courses to help improve computational thinking. As mentioned earlier, these individual knowledge building (IKB) activities described above were designed to build a foundation for collective knowledge activities for the TGP. Below are the findings from the collaborative knowledge building activities.

Collaborative knowledge building (CKB) in Class A. Collaborative knowledge building activities reflected each group's expertise in a digital literacy practice each group had chosen. For example, as shown in Figure 5-1, the problem-solving group of Class A built its knowledge using the class Google Docs worksheet, migrated what they constructed on the Google Docs to their webpage, and designed webpage layouts (see Appendix M for a group's published web page).

Google Docs worksheet of Class A	Problem-solving group's webpage



6.1. Explanation about problem solving with technology

Please be sure to answer **the 7 guiding questions (questions prompts)** found in the model / guidance site (Researching with technology: definitions, importance of research, changes in education, technologies for research, etc). When necessary, provide citations and reference section just as you can see in the model and guidance page. When giving feedback to other group's work, you can refer to this rubric. You can refer to this problem solving resource page when working on this part.

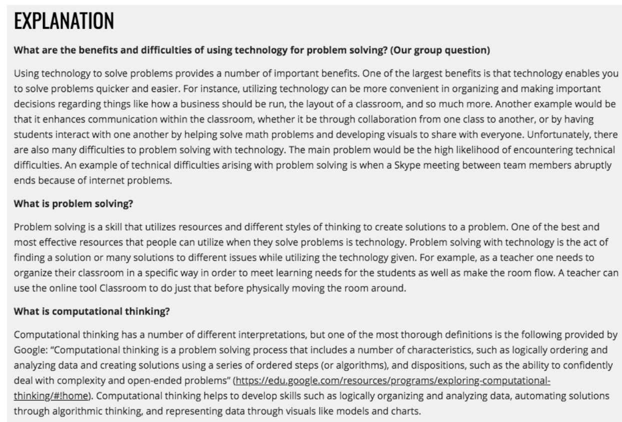
What are the benefits and difficulties of using technology for problem solving?

(Our group question)

Using technology to solve problems provides a number of important benefits. One of the largest benefits is that technology enables you to solve problems quicker and easier. For instance, utilizing technology can be more convenient in organizing and making important decisions regarding things like how a business should be run, the layout of a classroom, and so much more. Another example would be that it enhances communication within the classroom, whether it be through collaboration from one class to another, or by having students interact with one another by helping solve math problems and developing visuals to share with everyone. Unfortunately, there are also many difficulties to problem solving with technology. The main problem would be the high likelihood of encountering technical difficulties. An example of technical difficulties arising with problem solving is when a Skype meeting between team members abruptly ends because of internet problems.

What is problem solving?

Problem solving is a skill that utilizes resources and different styles of thinking to create solutions to a problem. One of the best and most effective resources that people can utilize when they solve problems is technology. Problem solving with technology is the act of finding



EXPLANATION

What are the benefits and difficulties of using technology for problem solving? (Our group question)

Using technology to solve problems provides a number of important benefits. One of the largest benefits is that technology enables you to solve problems quicker and easier. For instance, utilizing technology can be more convenient in organizing and making important decisions regarding things like how a business should be run, the layout of a classroom, and so much more. Another example would be that it enhances communication within the classroom, whether it be through collaboration from one class to another, or by having students interact with one another by helping solve math problems and developing visuals to share with everyone. Unfortunately, there are also many difficulties to problem solving with technology. The main problem would be the high likelihood of encountering technical difficulties. An example of technical difficulties arising with problem solving is when a Skype meeting between team members abruptly ends because of internet problems.

What is problem solving?

Problem solving is a skill that utilizes resources and different styles of thinking to create solutions to a problem. One of the best and most effective resources that people can utilize when they solve problems is technology. Problem solving with technology is the act of finding a solution or many solutions to different issues while utilizing the technology given. For example, as a teacher one needs to organize their classroom in a specific way in order to meet learning needs for the students as well as make the room flow. A teacher can use the online tool Classroom to do just that before physically moving the room around.

What is computational thinking?

Computational thinking has a number of different interpretations, but one of the most thorough definitions is the following provided by Google: "Computational thinking is a problem solving process that includes a number of characteristics, such as logically ordering and analyzing data and creating solutions using a series of ordered steps (or algorithms), and dispositions, such as the ability to confidently deal with complexity and open-ended problems" (https://edu.google.com/resources/programs/exploring-computational-thinking/#!home). Computational thinking helps to develop skills such as logically organizing and analyzing data, automating solutions through algorithmic thinking, and representing data through visuals like models and charts.

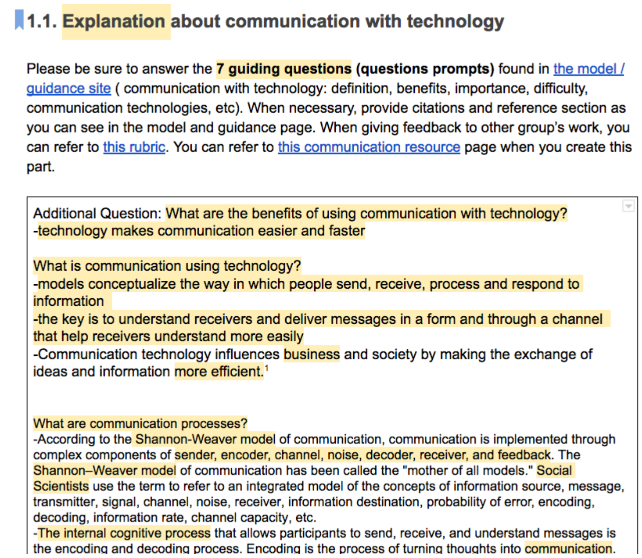
Figure 5-1. Section of Class A's Google Docs worksheet and the problem-solving group's webpage

Through their webpage, the problem-solving group shared the following thoughts about the *problem-solving* digital literacy practice through the published webpage:

> Problem solving is a skill that utilizes resources and different styles of thinking to create solutions to a problem. One of the best and most effective resources that people can utilize when they solve problems is technology. Problem solving with technology is the act of finding a solution or many solutions to different issues while utilizing the technology given. For example, as a teacher one needs to organize their classroom in a specific way in order to meet learning needs for the students as well as make the room flow. A teacher can use the online tool Classroom to do just that before physically moving the room around…

The problem-solving group's work illustrates that they developed a definition of problem-solving skills. The group's explanation also revealed their knowledge of solving problems with the help of technology. For example, through the research on problem-solving practices in education, they presented examples of solving problems with the help of technologies, such as meeting students' learning needs and designing classroom floor plans. In addition, the communication group of Class A co-constructed its knowledge of *communication* digital literacy practice and created the group's webpage on the class Web site, as shown in Figure 5-2.

Google Docs Worksheet of Class A	Communication group's webpage



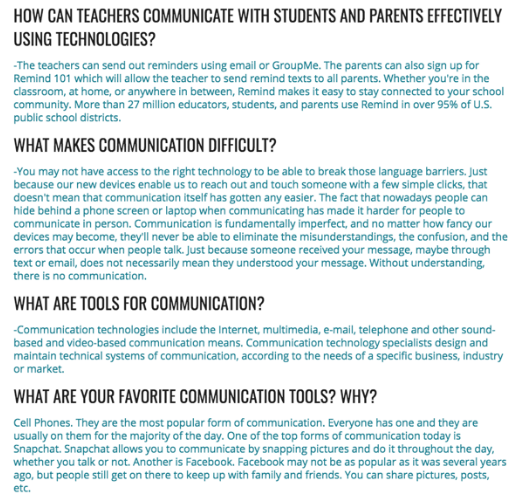
1.1. Explanation about communication with technology

Please be sure to answer the **7 guiding questions (questions prompts)** found in the model / guidance site (communication with technology: definition, benefits, importance, difficulty, communication technologies, etc). When necessary, provide citations and reference section as you can see in the model and guidance page. When giving feedback to other group's work, you can refer to this rubric. You can refer to this communication resource page when you create this part.

Additional Question: What are the benefits of using communication with technology?
-technology makes communication easier and faster

What is communication using technology?
-models conceptualize the way in which people send, receive, process and respond to information
-the key is to understand receivers and deliver messages in a form and through a channel that help receivers understand more easily
-Communication technology influences business and society by making the exchange of ideas and information more efficient.[1]

What are communication processes?
-According to the Shannon-Weaver model of communication, communication is implemented through complex components of sender, encoder, channel, noise, decoder, receiver, and feedback. The Shannon–Weaver model of communication has been called the "mother of all models." Social Scientists use the term to refer to an integrated model of the concepts of information source, message, transmitter, signal, channel, noise, receiver, information destination, probability of error, encoding, decoding, information rate, channel capacity, etc.
-The internal cognitive process that allows participants to send, receive, and understand messages is the encoding and decoding process. Encoding is the process of turning thoughts into communication.



HOW CAN TEACHERS COMMUNICATE WITH STUDENTS AND PARENTS EFFECTIVELY USING TECHNOLOGIES?

-The teachers can send out reminders using email or GroupMe. The parents can also sign up for Remind 101 which will allow the teacher to send remind texts to all parents. Whether you're in the classroom, at home, or anywhere in between, Remind makes it easy to stay connected to your school community. More than 27 million educators, students, and parents use Remind in over 95% of U.S. public school districts.

WHAT MAKES COMMUNICATION DIFFICULT?

-You may not have access to the right technology to be able to break those language barriers. Just because our new devices enable us to reach out and touch someone with a few simple clicks, that doesn't mean that communication itself has gotten any easier. The fact that nowadays people can hide behind a phone screen or laptop when communicating has made it harder for people to communicate in person. Communication is fundamentally imperfect, and no matter how fancy our devices may become, they'll never be able to eliminate the misunderstandings, the confusion, and the errors that occur when people talk. Just because someone received your message, maybe through text or email, does not necessarily mean they understood your message. Without understanding, there is no communication.

WHAT ARE TOOLS FOR COMMUNICATION?

-Communication technologies include the Internet, multimedia, e-mail, telephone and other sound-based and video-based communication means. Communication technology specialists design and maintain technical systems of communication, according to the needs of a specific business, industry or market.

WHAT ARE YOUR FAVORITE COMMUNICATION TOOLS? WHY?

Cell Phones. They are the most popular form of communication. Everyone has one and they are usually on them for the majority of the day. One of the top forms of communication today is Snapchat. Snapchat allows you to communicate by snapping pictures and do it throughout the day, whether you talk or not. Another is Facebook. Facebook may not be as popular as it was several years ago, but people still get on there to keep up with family and friends. You can share pictures, posts, etc.

Figure 5-2. Section of Class A's Google Docs worksheet and the communication group's webpage

The communication group published its collective knowledge of communication through the group's webpage on the class Web site. This group displayed its collective knowledge of communication as follows:

> …The teachers can send out reminders using email or GroupMe. The parents can also sign up for Remind which will allow the teacher to send remind texts to all parents. Whether you're in the classroom, at home, or anywhere in between, Remind makes it easy to stay connected to your school community. More than 27 million educators, students, and parents use Remind in over 95% of U.S. public school districts…
> …Just because our new devices enable us to reach out and touch someone with a few simple clicks, that doesn't mean that communication itself has gotten any easier. The fact that nowadays people can hide behind a phone screen or laptop when communicating has made it harder for people to communicate in person. Communication is fundamentally imperfect, and no matter how fancy our devices may become, they'll never be able to eliminate the misunderstandings, the confusion, and the errors that occur when people talk…

The communication group indicated that they had knowledge of commonly used communication tools in U.S. classrooms, such as GroupMe and Remind. The explanation indicated that they had the knowledge regarding how to connect with parents using Remind. Through their research, the group also offered information about how widely Remind is being used in the U.S. In addition, they understood the difficulties and limitations of communication by saying that even though we have diverse tools for communication, communication involves misunderstanding and errors.

Along with the collaborative knowledge building (CKB) about their group's digital literacy practice, participants from class A also built their collaborative knowledge regarding their chosen tool and digital literacy practices associated with it for creating their group video commercial. Table 5-12 shows Class A participants' knowledge regarding their group's chosen tool and digital literacy practices, which was shown in the published videos and video commercial plans. The data from the published videos and video commercial plans (see Appendix N) indicated that the collaborative learning processes of designing video commercial plans and creating video commercials helped participants gain knowledge of their chosen tools and related digital literacy practices.

Table 5-12

Class A Participants' Knowledge about their Chosen Tool as Shown in Video Commercials

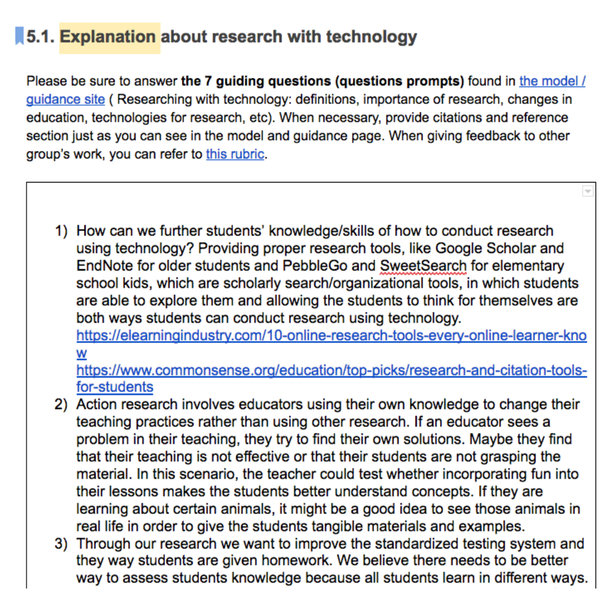
Group	**Chosen Tool**	**Knowledge about the tool and digital literacy practice**
Communication	GroupMe (Messenger)	• Solving communication problems • Communicating and collaborating across devices • Setting up events and conducting polls while communicating and collaborating
Collaboration	Class123 (Classroom management)	• Solving problems with teachers' and students' learning management as well as parents' management of their children's learning • Informing parents of and involving them in the classroom activities
Creating & Publishing	Tinkercad (3D modeling)	• Creating 3D models to realize creative designs • Sharing 3D models designed by people around the world • Printing 3D models
Digital Citizenship	Zoom (Video conference)	• Helping students improve skills about digital citizenship through creating a profile, respecting other people, and establishing professional online identities • Holding online video conferences with large groups of people by establishing adequate digital citizenship
Research	Pinterest (Visual social bookmarking)	• Conducting visual research on the topic of interests
Problem solving	CodeMonkey (Block programming)	• Help people code easily with block programming • Improving computational thinking and design thinking with coding

As shown in Table 5-12, each group chose a tool that corresponds to their group's digital literacy practice and identified the technological affordances of each tool that supports their group's digital literacy practice. For example, the creating and publishing group (A) selected the Tinkercad 3D modeling tool and gained knowledge of how to utilize the tool for creating artifacts for 3D printing and sharing designed artifacts with other people. Therefore, participants' published video commercials revealed their knowledge of tools that can help educators and learners implement digital literacy practices.

Groups from Classes B and C also published knowledge of their topic of digital literacy practice as shown in the following section.

Collaborative knowledge building (CKB) in Classes B and C. Similar to Class A, participants from Classes B and C also constructed their knowledge using the class Google Docs worksheet and designed webpages on the class Web site. For example, the research digital literacy group (B) co-constructed the class Google Docs worksheet and published their group's webpage as shown in Figure 5-3.

Google Docs Worksheet of Class B	Research group's webpage



5.1. Explanation about research with technology

Please be sure to answer **the 7 guiding questions (questions prompts)** found in the model / guidance site (Researching with technology: definitions, importance of research, changes in education, technologies for research, etc). When necessary, provide citations and reference section just as you can see in the model and guidance page. When giving feedback to other group's work, you can refer to this rubric.

1) How can we further students' knowledge/skills of how to conduct research using technology? Providing proper research tools, like Google Scholar and EndNote for older students and PebbleGo and SweetSearch for elementary school kids, which are scholarly search/organizational tools, in which students are able to explore them and allowing the students to think for themselves are both ways students can conduct research using technology. https://elearningindustry.com/10-online-research-tools-every-online-learner-know https://www.commonsense.org/education/top-picks/research-and-citation-tools-for-students
2) Action research involves educators using their own knowledge to change their teaching practices rather than using other research. If an educator sees a problem in their teaching, they try to find their own solutions. Maybe they find that their teaching is not effective or that their students are not grasping the material. In this scenario, the teacher could test whether incorporating fun into their lessons makes the students better understand concepts. If they are learning about certain animals, it might be a good idea to see those animals in real life in order to give the students tangible materials and examples.
3) Through our research we want to improve the standardized testing system and they way students are given homework. We believe there needs to be better way to assess students knowledge because all students learn in different ways.

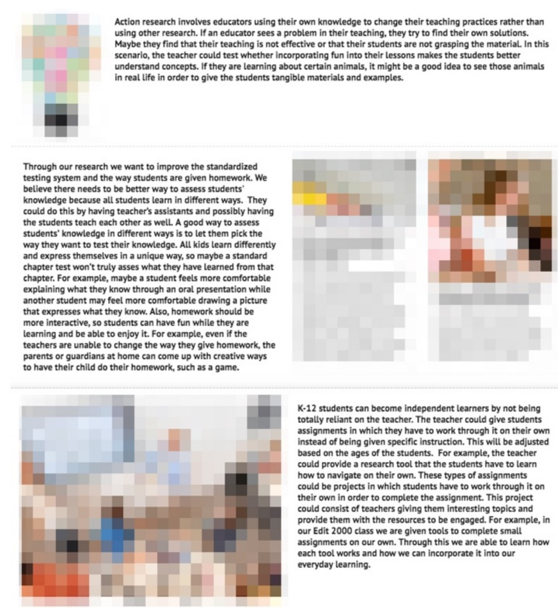


Figure 5-3. Section of Class B's Google Docs worksheet and the research group's webpage

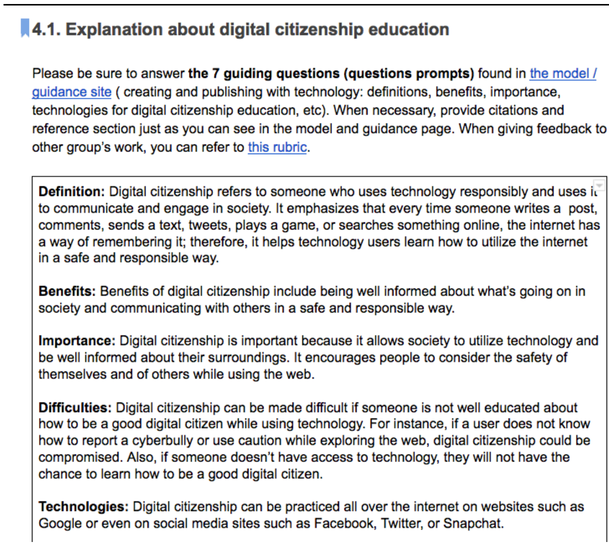
The research group (B) shared its collective knowledge regarding *research* digital literacy practice in the following:

> …We will provide proper research tools, like Google Scholar and EndNote for older students while using PebbleGo and SweetSearch for elementary school kids. These tools are scholarly search/organizational instruments. The students are able to explore them and think for themselves, both of which are ways students can conduct research by using technology…
> …K-12 students can become independent learners by not being totally reliant on the teacher. The teacher could give students assignments in which they have to work through it on their own instead of being given specific instruction. This will be adjusted based on

> the ages of the students. For example, the teacher could provide a research tool that the students have to learn how to navigate on their own. These types of assignments could be projects in which students have to work through it on their own in order to complete the assignment. This project could consist of teachers giving them interesting topics and provide them with the resources to be engaged. For example, in our E*** 2*** class we are given tools to complete small assignments on our own. Through this we are able to learn how each tool works and how we can incorporate it into our everyday learning…

The research group's collective knowledge revealed their knowledge of research tools such as PebbleGo and SweetSearch as well as their understanding of implementing digital literacy practices in K-12 classrooms, which can help K-12 students become independent researchers. For example, they proposed a research project in which students conduct independent research regarding interesting topics with the help of research tools and resources, just as the students in this study were doing during the TGP. In addition, the digital citizenship group (C) also demonstrated its knowledge of digital literacy practices through its published webpage after constructing its knowledge on the class Google Docs worksheet as shown in Figure 5-4.

Google Docs Worksheet of Class C	Digital Citizenship group's webpage



4.1. Explanation about digital citizenship education

Please be sure to answer **the 7 guiding questions (questions prompts)** found in the model / guidance site (creating and publishing with technology: definitions, benefits, importance, technologies for digital citizenship education, etc). When necessary, provide citations and reference section just as you can see in the model and guidance page. When giving feedback to other group's work, you can refer to this rubric.

Definition: Digital citizenship refers to someone who uses technology responsibly and uses it to communicate and engage in society. It emphasizes that every time someone writes a post, comments, sends a text, tweets, plays a game, or searches something online, the internet has a way of remembering it; therefore, it helps technology users learn how to utilize the internet in a safe and responsible way.

Benefits: Benefits of digital citizenship include being well informed about what's going on in society and communicating with others in a safe and responsible way.

Importance: Digital citizenship is important because it allows society to utilize technology and be well informed about their surroundings. It encourages people to consider the safety of themselves and of others while using the web.

Difficulties: Digital citizenship can be made difficult if someone is not well educated about how to be a good digital citizen while using technology. For instance, if a user does not know how to report a cyberbully or use caution while exploring the web, digital citizenship could be compromised. Also, if someone doesn't have access to technology, they will not have the chance to learn how to be a good digital citizen.

Technologies: Digital citizenship can be practiced all over the internet on websites such as Google or even on social media sites such as Facebook, Twitter, or Snapchat.

Figure 5-4. Section of Class C's Google Docs worksheet and the digital citizenship group's webpage

The digital citizenship group in Class C published the following content to the webpage on the class Web site:

> A digital citizen refers to someone who uses technology responsibly and uses it to communicate and engage in society. Digital citizenship emphasizes that every time someone writes a post, comments, sends a text, tweets, plays a game, or searches something online, the Internet has a way of remembering it; therefore, it helps technology users learn how to utilize the Internet in a safe and responsible way. The benefits of digital citizenship include being well informed about what's going on in society and communicating with others in a safe and responsible way. Digital citizenship is important because it allows society to utilize technology while being well informed about their surroundings. It encourages people to consider the safety of themselves and of others while using the Web. Digital citizenship can be made difficult if someone is not well educated about how to be a good digital citizen while using technology. For instance, if a user does not know how to report a cyberbully or use caution while exploring the Web, digital citizenship could be compromised. Also, if someone doesn't have access to technology, they will not have the chance to learn how to be a good digital citizen. Digital citizenship can be practiced all over the Internet on Web sites such as Google or even on social media sites such as Facebook, Twitter, or Snapchat.

The digital citizenship group in Class C indicated they had a collective knowledge of what digital citizenship is and involves. Further, the group described why digital citizenship is important in terms of safety and responsibility. They also noted that people can benefit from learning digital citizenship because they will be informed of how to use technology adequately according to circumstances. For example, they explained the importance of digital citizenship with regard to addressing cyberbullies while exploring the Web. Finally, they indicated their knowledge of establishing digital citizenship using the Web and social media.

In addition to the collaborative knowledge building (CKB), participants from Class B designed their groups' video commercial plans and created video commercials for their chosen tools as shown in Table 5-13. The data from the video commercials and plans provides evidence that participants learned the knowledge of diverse tools and digital literacy practices. They explored their chosen tools such as Voicethread, Google Drive, Tinkercad, Thingiverse, and BrainPOP and learned about technological affordances of these tools with regard to their group's digital literacy practices. For example, the communication group chose Voicethread asynchronous communication tool, and its video commercial indicated their knowledge of how to facilitate online discussion using multimodal media.

Table 5-13

Class B Participants' Knowledge about their Chosen Tool as Shown in Video Commercials

Group	**Chosen Tool**	**Knowledge about the tool and digital literacy practice**
Communication	VoiceThread (Multimodal communication)	• Promoting discussion between students through multimodal messages such as texts, audio, images, and videos
Collaboration	Google Drive (Collaborative cloud storage)	• Collaborating without the restrictions of time and space • Diverse collaborative tools within Google Drives, such as Google Docs, Google Sheets, and Google Slides
Creating & Publishing	Tinkercad & Thingiverse (3D model creating & publishing)	• Helping students become 3D model creators easily with the help of resource provided • Helping students become publishers of their created 3D models
Digital Citizenship	BrainPOP (Animated videos for education)	• Helping students learn digital citizenship in terms of diverse topics such as copyright, cyberbullying, and digital etiquette • Providing online courses regarding digital citizenship
Research	Pinterest (Visual social bookmarking)	• Engaging students and teachers in research projects • Combining the features of social media and search platforms • Collaborating using the feature of creating boards
Problem solving	Microbit (Pocket-sized computer)	• Improving students' skills about design thinking and computational thinking • Help students improve their problem-solving skills through block coding

Similarly, participants from Class C created and published their group's video commercial as shown in Table 5-14. They advertised the features of their chosen tools—Kahoot, Google Docs, new Google Sites, GroupMe, Pinterest, Ozobot, and Blockly—in association with their group's digital literacy practice. Among them, the problem-solving group (C) publicized

Ozobot and Blockly and introduced them as tools for improving computational thinking through robots and block programming. The participant groups' video commercial plans and published video commercials indicated that they had an understandings of the technological affordances of the tools and how to use them for digital literacy practices.

Table 5-14

Class C Participants' Knowledge about their Chosen Tool as Shown in Video Commercials

Group	Chosen Tool	Knowledge about the tool and digital literacy practice
Communication	Kahoot (Interactive quiz)	• Giving instant feedback on students' knowledge and understanding • Tracking students' progresses in big classes and communicating the progresses with students • Allowing students to collaborate in answering quizzes
Collaboration	Google Docs (Collaborative word processing)	• Helping people work together to solve difficult problems
Creating & Publishing	new Google Sites (Website publishing)	• Creating and publishing Web sites with ease
Digital Citizenship	GroupMe (Messenger)	• Helping students establish adequate digital citizenship through group chatting tools • Modeling adequate digital citizenship through GroupMe
Research	Pinterest (Visual social bookmarking)	• Using other people's shared resources for research purposes • Identifying good resources through people's reviews and comments
Problem solving	Ozobot & Blockly (Robots & block programming)	• Programming robots with Blockly • Improving computational thinking

The findings from group interviews about the participants' digital literacy knowledge building are as follows.

Group interviews with participants from Class A. I interviewed two groups from Class A (see Table 3-15 for the group interview participants). As mentioned in Chapter 3, I chose the two groups because one group was very visibly active during their collaboration, and the other group worked together in a calm and focused manner. Both groups were relatively highly engaged groups among the Class A groups. The analysis of group interview data provided evidence of the growth of the interview participants' digital literacy knowledge. For example, in the group interview, Amelia (A) said, "I feel like I learned a lot more about how to use technology, and I didn't really know all the aspects of it beforehand. So, I felt like that helped me to learn more about it." She indicated that she learned the knowledge regarding multiple aspects of using technology through the TGP. In addition, Andrea (A) stated:

> Okay, um I enjoyed it. I learned a lot about kind of the different tools that you can use like a lot of the ideas. I was familiar with the research and collaboration and all that stuff, but I didn't know specifically a lot of the stuff that you could use like especially with the tool commercial stuff and learning about like CodeMonkey and then all the other groups like apps that you can use for things. I thought that was really cool. Especially to take into like the workplace when I grow up to be like. Hey, I know this thing that we can use to like present or talk or get work done I think.

Andrea indicated that she learned different tools and apps she could use in her future workplaces while she prepared for or engaged in creating her group's video commercials for their chosen tools. She also mentioned that she learned about different tools from other groups. Similarly, Amanda, who belonged to the same group as Andrea, said:

> I didn't realize like how in depth like each topic was like. I would have never thought like problem solving would like go this deep like. I didn't know there were different types of like things like problem solving and different types of thinking. Mmm, same goes for like publishing and like collaboration and cooperation and know like everything would go as in-depth as it did.

Amanda's comments indicated that she learned about digital literacy practices such as solving problems, publishing, and collaborating through the TGP, which covered the digital literacy topics in depth. Her statement revealed that she built knowledge of her own group's digital literacy practice as well as other digital literacy practices from the work of other groups. The group interviews with participants from Classes B and C also indicated the growth of their knowledge of digital literacies, as shown in the following section.

Group interviews with participants from Classes B and C. The findings from the group interview data (n = 5, see Table 3-15 for the group interview participants) from Classes B and C were similar to those from Class A in that they demonstrated the groups' knowledge of digital literacy practices. For example, when asked what they learned about digital citizenship, Anne, Sophia, and Jane (Class B) responded as follows:

> **Anne**: I guess certain Web sites you have to be careful about because they're not necessarily safe. Even though they may look safe, you just have to make sure like. I guess sometimes the ads that pop up too can be kind of inappropriate. So, you just have to make sure it's like a kid-friendly Web site, I guess.
> …
> **Sophia**: With our type of tool we chose like, we chose Pinterest and with that Web site it's like not as formal. So, you have to be careful with that kind of platform that you're researching on and with research in general so…
> …
> **Jane**: I agree too with Sophia about the Pinterest. Because anyone can post it and make a board there. So, it could be a little biased sometimes.
> **Anne**: You have to be really specific with what you are searching.

After researching Pinterest as their group's tool to advertise, Anne, Sophia, and Jane revealed their knowledge of Pinterest as well as their understanding of safety issues with regard to Web sites and the reliability of information found on the Pinterest Web site in terms of *digital citizenship* digital literacy practice. In addition, regarding their learning about *research* digital literacy practice, Chris, Chelsea, Rachel, and Jasmine (Class C) responded as follows:

> **Chris**: I think we learned that there's a lot of different tools that helps to make research easier.
> **Chelsea**: Oh, yeah.
> **Chris**: And a lot of different applications so mmm…

Chelsea: We just use like type everything in Google. There's a lot of different like research tool we can use.
Rachel: A lot of tools not even just like as far as going to the library like looking things up like Google is a great research tool. We said Pinterest was there is like research should be as little as like wanting a recipe or something.
Jasmine: Even like within Google like learning about how to use like Google Images search and like Google Scholar so specifically and…

Chris, Chelsea, Rachel, and Jasmine indicated they learned about multiple tools, such as Pinterest, Google Images, and Google Scholar, which helped them conduct research. Pinterest and Google Scholar were introduced to students as research tools during the class. In addition, students learned how to use and apply the Google Images tool for searching, as one of the Tech force/Model lesson activities (see Appendix O) during the TGP. Alongside with participants' understanding of digital literacy practices, they also displayed their technological skills with regard to digital literacy practices, which I explain in the next section.

Theme 2: Improved Digital Literacy Skills and Utilization of Existing Digital Literacy Skills

The second theme emerged from the data from field notes, group interviews, and participant products. The data indicated participants' improved technological skills in implementing digital literacy practices such as interacting with each other, creating, designing, and publishing. In addition, when they designed and published video commercials, their computational thinking capabilities were implicitly revealed. Participants also used the digital literacy skills they already had, such as research skills, to complete the TGP. The data below indicated that students were capable of using technology to implement digital literacy practices.

Observation and participant products. Most students from Class A did not have prior knowledge and skills regarding the creation of Web sites on the new Google Sites platform at the first day of the TGP. In contrast, most students from Classes B and C had the basic knowledge and skills regarding creating and publishing Web sites on the new Google Sites platform before the TGP. Participants developed their digital literacy skills across 10 phases. Table 5-15 presents the moments of participants' digital literacy skill building processes.

Table 5-15

Observed Moments of Digital Literacy Skill Building Processes during the TGP

Phases	Topics	Observed moments of digital literacy skill development during the TGP
1	Introduction	• **Learning skills of creating and publishing Web content on new Google Sites Platform** - On the first day, some students from Classes B and C lacked the following skills: 1. Some students did not know how to create pages on the new Google Sites platform. 2. Some students did not know how to embed YouTube videos. 3. Some students did not know how to copy a Google Docs document to their Google Drive. 4. Some students did not know how to set Google Docs to public so that anyone could see it with provided links. 5. Some students did not know how to set Padlet online walls to public. 6. Some students did not know how to get the embed code from created Padlet online walls. 7. Some students did not know how to get sharing links from new Google Sites. - On the first day, 7 students among the 16 students (present) in Class A completed the task of creating and publishing web content on the new Google Sites platform. Among the tasks above, the Padlet related activity was removed from Class A activities considering the time restrictions and the prior knowledge and skills of Class A. - On the second day of the TGP in Class A, 16 students eventually submitted published Web sites. - 17 students among the 19 students (present) from class B succeeded in completing the tasks by overcoming the difficulties shown above on the first day. In addition, 13 students among the 18 students (present) from C succeeded in the tasks on the first day.

2 to 7	- IKB - CKB, - Tech force/Model lesson - Video commercial design - Lesson plan design	• **Implementing *collaboration* digital literacy practice on Google Docs** - A student from Class A asked how the class could give feedback on other groups' work. Antonio showed how to give feedback to other groups and asked his students not to delete other students' feedback comments but to use the *resolve* feature in Google Docs. - After learning the comment feature in Google Docs, students from Classes A, B, and C engaged in reading other groups' work and gave feedback on other groups' work. • **Implementing *communication* digital literacy practices** - Students from classes A, B, and C communicated with each other using multimodal media through Google Docs in the processes of creating the explanation sections, video commercial plans, and lesson plans. • **Implementing *problem-solving* digital literacy practice** - Students from Classes A, B, and C created webpage content to communicate with other educators in need, designed video commercials to communicate the feature of their chosen tools effectively, and designed lesson plans to teach specific Georgia standards by incorporating technology into lesson plans. • **Implementing *research* digital literacy practice** - Students from classes A, B, and C conducted research on their group's digital literacy practices to create the explanation section, video commercial plan, and lesson plan.
8	Video Commercials Creation	• **Implementing creating/publishing/establishing digital citizenship digital literacy practice** - Since this phase was an independent work day, most student groups did not come to class. Instead, most groups chose to meet at other places besides the usual classroom. I noticed the research group (B) and the communication group and the creating and publishing group (C) came to class to create their videos. The research group from (B) was not sure how to save edited video files through the iMovie video editing tool and publish iMovie files to YouTube. I helped them save the file and publish it to YouTube.
9	Webpage design and publishing	• **Creating, designing, and publishing webpages** - Antonio demonstrated how to create webpages, how to insert open access images from Google, how to create sections, and how to format texts on new Google Sites. - At first, I was concerned about students' progress in Class A, but it turned out that all groups completed their work in the end. In terms of the design aspect of the webpages, I felt there was something to be desired, but they worked at home and completed their work eventually. I was satisfied with their work.

		- In Class B, I walked around busily to check out their progress and guide design and publishing activities. I guided them to make font size larger for visibility. I was greatly impressed by the work of the research group in terms of their webpage design. - I usually had busier times in Class C because some groups, such as creating and publishing group and collaboration group, were often behind. I encouraged students in Class C to design and publish their webpages within the class period. Eventually, all the groups succeeded in publishing their webpages.
10	Presentation	Students had the opportunity to learn from other groups' communication and design skills that were shown in their products.

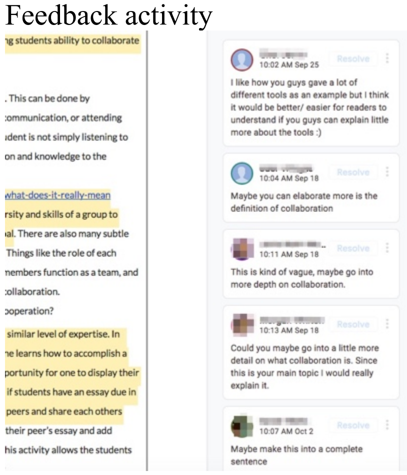
As Table 5-15 presents, students implemented digital literacy practices to achieve the goal of communicating their knowledge with other educators. In the process of achieving the goal, from phase 2 to phase 9, students engaged in digital literacy practices of communicating, collaborating, creating, designing, publishing, and establishing digital citizenship rather than learning how to use specific tools. However, in phase 1 of the TGP, it was necessary for the students to have skills in creating and publishing Web content on new Google Sites for the successful completion of the TGP.

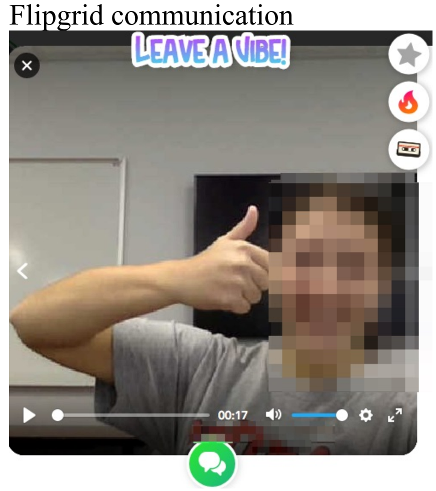
Therefore, as shown in Table 5-15, at the beginning of the TGP, participants from Classes A, B, and C practiced creating and publishing web content on new Google Sites. Because the participants from Classes B and C had prior knowledge of and skills in creating and publishing web content using embedding, the participants from Classes B and C displayed more developed skills in creating and publishing compared to those from Class A. Eventually, participant groups from Class A learned how to create and publish web content at the end of the TGP (see Appendix P) and successfully communicated their digital literacy knowledge using multimodal media with people around the world.

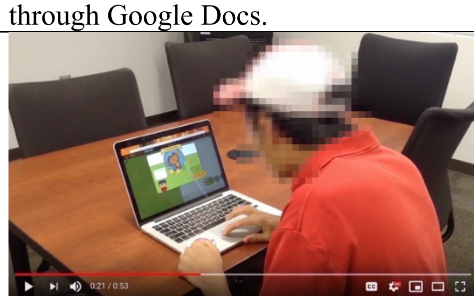
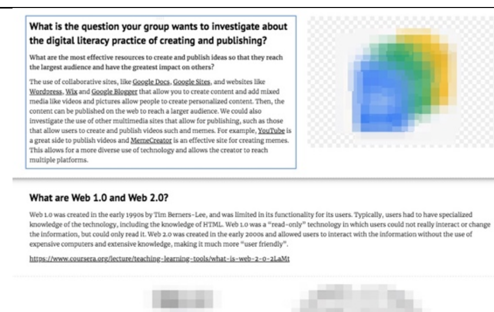
Participant products from collaborative knowledge building (CKB) activities, the Tech force/Model lesson activities, video commercials for their chosen tools, and class Web site publishing activity showed participants' digital literacy skills regarding digital literacy practices. For example, Table 5-16 presents participants' technological skills corresponding to each digital literacy practice.

Table 5-16

Participant Products Showing Digital Literacy Skills

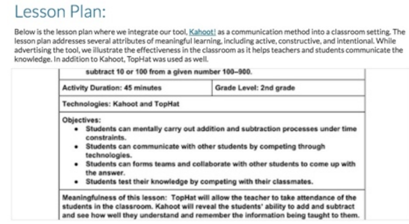
<table>
<tr><th>Skills</th><th colspan="2">Participant product examples from Classes A, B, and C</th></tr>
<tr><td>Social Interaction</td><td>Feedback activity


This feedback activity from the collaborative knowledge building (CKB) activity showed participants' communicative and collaborative skills through Google Docs.</td><td>Flipgrid communication


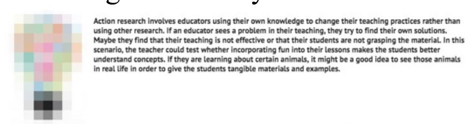
The Flipgrid video communication activity as a part of Tech force/Model lesson showed students' technological skills regarding communicating through videos.</td></tr>
<tr><td>Creating / Publishing / Establishing digital citizenship</td><td>
All the groups from Classes A, B, and C succeeded in joining the participatory culture of publishing their respective groups' videos to YouTube to share their expertise in using their group's favorite technologies for education.</td><td>

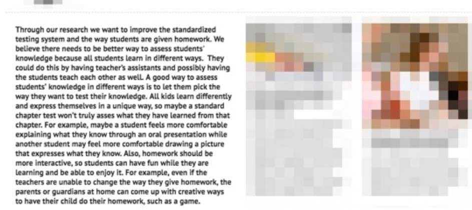
All the groups from Classes A, B, and C shared their knowledge of digital literacy practices and useful tools for education by publishing their webpages composed of texts, images, and videos by establishing digital citizenship as educator identities.</td></tr>
</table>

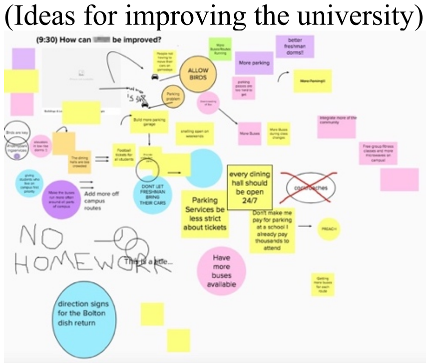
<table>
<tr>
<td>Research</td>
<td>

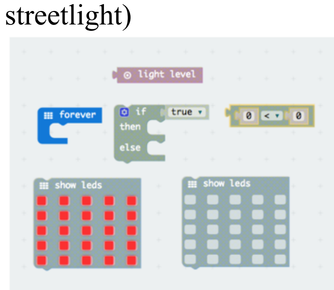

All the groups from Classes A, B, and C conducted research on the Web for the purpose of sharing their knowledge of digital literacy practices.
</td>
<td>


All the groups from Classes A, B, and C researched their chosen tools for the video commercials; the Georgia state standards; and possible ways of integrating technology meaningfully into education.
</td>
</tr>
<tr>
<td rowspan="2">Problem Solving</td>
<td>
Designing videos in the form of commercials using computational thinking skills such as abstracting the features of tools, identifying patterns of commercial films, and sequencing stories to communicate


All the groups from Classes A, B, and C engaged in designing tool commercials.
</td>
<td>
Designing Web sites to communicate knowledge effectively




All the groups from Classes A, B, and C engaged in webpage design activities to deliver information effectively.
</td>
</tr>
<tr>
<td>
Design Thinking Activity
(Ideas for improving the university)


Most students from Classes A, B, and C engaged in design thinking activity using Mural online wall.
</td>
<td>
Computational Thinking Activity
(Microbit coding: the light-sensing streetlight)


Most groups from Classes B and C successfully completed the Microbit coding task, but students from Class A could not because of the restrictions of time.
</td>
</tr>
</table>

The participant products shown in Table 5-16 shows participants' general technological skills in implementing the six digital literacy practices. Regarding *social interaction* digital literacy skills such as communication and collaboration, at the beginning of the TGP (phase 2), participants from Classes A, B, and C were not familiar with the comment feature of Google Docs (see Table 5-16 for student feedback activities). After learning how to leave and resolve comments on Google Docs from Antonio and me, they engaged in between-group communication without any difficulties. Participants' products such as Google Docs worksheet, published web pages, and published video commercials (see Table 5-16) indicated that participants can implement *communication* digital literacy practices by combining multimodal media such as texts, images, audio, and videos.

Regarding digital citizenship establishment, participants' published lesson plans (see Appendix Q1, Q2, and Q3 for examples of lesson plans), webpages, and video commercials (see Table 5-16 for the published example of a YouTube video and a webpage) indicated that they assumed the identity of educators sharing their knowledge of digital literacy practices. In addition, participant groups easily understood the discourses in video commercials when they designed, created, and published their video commercials. This easy adoption of discourses often found in TV commercials seemed to result from their familiarity with TV commercials. This collective identity establishment as educators and video commercial creators appeared to be facilitated through the goal of the TGP, question prompts, worked example sites, and video commercial plan template for their chosen tool, and a lesson plan template. However, in retrospect, regarding establishing adequate digital citizenship, using public domain images should have been more emphasized for designing webpages because I was unsure whether all the images on the class Web site were public domain images despite the instructors' explanations about using open access images.

Regarding the skills for the digital literacy practice of conducting research (see Table 5-16 for examples of participants' research results), most participants from all the classes seemed to have no difficulties in searching for information for the purpose of creating explanation sections, video commercials for their chosen tool, and lesson plans. Through the Tech force/Model lesson activities regarding *research* digital literacy practice, participants had the opportunities to engage in the digital literacy practice of finding information using Google Images search and managing information through digital notes. However, students from Antonio's class did not have enough time to complete these research related activities. Nevertheless, most participants from all the classes seemed to have no difficulties in searching for information and building their knowledge regarding digital literacies based on their research findings.

Regarding the *problem-solving* digital literacy practice (see Table 5-16 for examples of participants' *problem-solving* digital literacy practice), participants designed their group's webpage by choosing adequate cover images for their group's digital literacy practice and engaging in design decisions on layouts of webpage components such as texts, images, and videos. For example, the problem-solving group in Class C seriously considered how to communicate their lesson plans effectively. As a result, their webpage design was very different from other groups' as shown in Appendix Q4 . They indicated that the lesson plan template could not communicate their lesson activity designs and asked me for permission to add additional sections after the embedded lesson plan. After I gave them permission, they designed the layout of the lesson plan content in a creative way by creating columns within page sections and completing each column using texts and images.

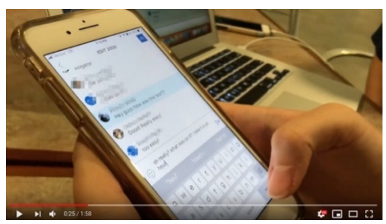
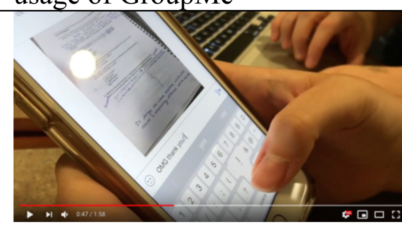
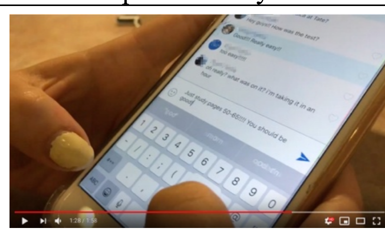
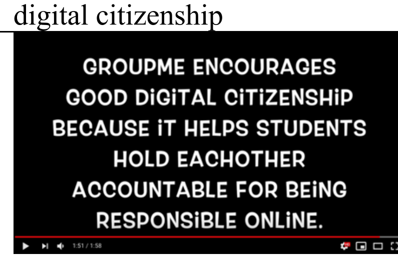
In addition, participants' computational thinking skills as a creative thinking process (DeSchryver & Yadav, 2015; Mishra, Yadav, & the Deep-Play Research Group, 2013; Wing, 2017) were implicitly shown when they designed a video commercial plan and created video commercials as shown in Table 5-17. Among the computational thinking skills (DeSchryver & Yadav, 2015) such as abstraction, pattern recognition, iteration, logical organization, symbol representation, and algorithmic thinking, participant video commercial plans and video commercials indicated that participants abstracted the technological affordances of their chosen tools, recognized patterns of video commercials, sequenced images and videos with logical and algorithmic thinking in the iterative processes of designing, recording, and editing video commercials. The scenes and stories from a video commercial, as shown in Table 5-17, indicate that the group abstracted the features of GroupMe messenger tool, sequenced texts, audio (music), and videos based on a dramatic storyline, and edited the video to follow the patterns of video commercials. This example of a GroupMe video commercial indicates that participants employed computational thinking skills to design and create their video commercials.

Table 5-17

Computational Thinking Skills Shown in Video Commercial Plans and Video Commercials

Computational Thinking	**Video commercial plans and published video commercials**
Abstraction	• Identification of key functions in the video commercial plan • Abstraction of key functions of GroupMe: smartphone group message feature
Pattern recognition	• Identification of message formats in TV commercials • Incorporating dramatic elements into the video commercial within a limited time frame by combining scenes, stories, texts, and music together
Algorithmic thinking	• Sequenced events following storylines

Scenes and Stories from a Published Video Commercial

Introduction (text+lively music)	Cheating through GroupMe	Grave music about inappropriate usage of GroupMe
		
Adequate digital citizenship	Example of good digital citizenship with lively music	GroupMe ads with regard to digital citizenship
		

In addition, students had opportunities to practice their problem-solving skills through Tech force/Model lesson activities, although they were not directly associated with the goal of the TGP. For example, they collectively shared ideas about how to solve problems the university had and were asked to program a street light which turned on and off according to the level of light. The participants from Classes B and C had relatively more time for those activities than those from Class A. Antonio and I had to reduce or skip much of the Tech force/Model lesson activities in Class A because we wanted to ensure that students had enough time for collaborative knowledge building activities. Considering the students from Classes B and C had had other opportunities to improve their design thinking and computational thinking skills before the TGP, it seemed that they had more learning opportunities regarding *problem solving* digital literacy practices than those from Class A.

In addition to my observation and participants' products, the group interviews with the participants also revealed participants' skills regarding digital literacy practices as shown in the following section.

Group interviews with participants from Class A. Participants in Class A interacted with each other through a Google Docs worksheet and engaged in co-creating a class Web site by researching and designing. Regarding technological skills that she learned, Amanda (A) stated:

> I never really used any of the Google tools like as in-depth just because like some professors in different classes have different preferences as to what like we should use for an assignment. So, getting to really like play around with that and like Google Sites existed for being honest. Just getting to play around with getting that experience was really cool.

As Amanda mentioned, students used Google tools such as Google Docs and new Google Sites extensively during the TGP. They were mainly used as platforms for creating, designing, and publishing web content collaboratively. Therefore, while participants were doing the TGP, they learned the skills to interact with each other, create and design web content, and publish to the class Web site. In addition, regarding learning technological skills, Mark (A) said:

> I know there was a few for like classroom management and there was also a couple that were for group meetings like. I think there's one called Zoom something and allows you to like create a group meeting at any time and like give the code to somebody so they can join and that makes things easier.

Mark indicated that he learned how to hold online conferences using Zoom, although in Class A, the tool was merely introduced to them without explicit opportunities to practice holding online conferences. Regarding their acquisition of digital literacy skills, Emma (A) said, “I thought it’d be a lot harder to like publish a website. It’s pretty easy.” This indicated that she easily obtained the digital literacy skills in creating and publishing a website. Similarly, Amelia from the same group said, “creating and publishing was a big one for me. I didn't really know anything about creating a website or anything like that before. So, that was helpful.” She indicated that the digital literacy skills regarding creating and publishing were helpful for her.

Participants also used digital literacy skills they already had to complete the tasks of the TGP. Regarding *research* digital literacy practices that were employed when her group investigated the tool that her group’s video commercial would advertise, Amelia (A) stated:

> I think we just had to do some research on the app that we were using um just to make sure we knew all the important details about it, and then we kind of brainstormed ideas of how it would be helpful, mmm, as like a teacher or a parent or student so…

Amelia indicated that her group conducted research to find out the features of the tool they would advertise. Afterward, they shared their ideas about how the tool would help educators, parents, and students. This showed that the participants could conduct their own research without specific help from the instructors. The research skills they had already acquired before the TGP became a foundation for creating their groups’ video commercials for their chosen tools. The group interviews with the participants from Class A revealed they used digital literacy skills such as interacting with each other, conducting research, creating, and publishing.

Group interviews with participants from Classes B and C. Interview participants from Classes B and C (n = 5) also indicated their improved technological skills. In addition, they also used their existing digital literacy skills to accomplish the collective goal. First, Nadin (B) stated:

> I've used like Google Docs and everything before, but I feel like the fact that we were like using it to do our actual project, and that was also like, the tool that we were like studying for our project. It was kind of interesting to see like in real time like how it actually helped us you know, finish the task.

Nadin indicated that she learned how to use Google Docs for the class project. Even though she had prior experiences in using Google Docs, it was a new experience for her to use Google Docs to accomplish the goal of the project. Nadin's response indicated she learned how to use Google Docs in the processes of implementing digital literacy practices. Regarding their technological skills that they learned during the TGP, Sophia and Anne (B) responded as follows:

> **Sophia**: I learned a lot more about technology from this project because I was not good with technology before and now I feel like using like them, [asks other students] What did we use? Mov.. [all at the same time] iMovie [by herself] iMovie and everything. I feel like better about it and like we had embed and that kind of stuff.
> **All**: Yeah
> **Anne**: I did learn a lot with that.

The interview participants said that they learned iMovie even though the tool was not introduced directly during the TGP. This indicated that they improved their skills in creating and editing videos to create their group's video commercials for their chosen tools. In addition to iMovie, Sophia also mentioned she learned how to embed web content such as YouTube videos and Google Docs into web pages, which they practiced and implemented during the TGP. This revealed improvement in their creating and publishing skills. In addition, Ava, Megan, and Luke (Class C) indicated they learned technological skills regarding interacting with others and publishing web content. They responded as follows:

> **Ava**: I would say Google Sites for me because I've never used that before and like even like Word or like PowerPoint or anything like that. I'm on the very low like understanding level. Um so like being exposed to Google Docs and like sharing between and seeing how like people can comment and people can edit you know, and then you can accept it and change it. I don't know. It's just it's a cool way to collaborate.

> **Megan**: I think in work and my past internship and, and like ***, my ***** classes I've used a lot of like Google like I use a lot of Google Sheets and a lot of like Google Docs, but it's been cool to see like you said like editing or like collaborating with that cuz I've learned how, I mean we just like we'll send it to each other like share it like actually gained a comment was something that I liked. I even told some my friends I was like you can like just comment right there yeah and that's just something I've never known before.
> …
> **Luke**: Yeah, it's very helpful. It's like an easy way to get more input like just your own cuz like really any other perspective besides yourself is useful.

Ava mentioned her technological learning of new Google Sites, and Ava, Megan, and Luke commonly stated how they benefitted from learning the skill of collaborating on Google Docs using its comment feature. For example, Megan said that even though she had experiences in using Google Docs for her other classes, it was new to her collaborating on Google Docs through the processes of editing together on a Google Docs document and giving feedback comments on other groups' work. Regarding *research* digital literacy practices, participants from Classes B and C also had prior knowledge about finding the information they needed online. For example, regarding the way his group answered the guiding questions, Evan (C) stated:

> What we couldn't find on, on your Web site we just like looked up online to just like educate ourselves to the point of being able to like write about it and explain it to the class.

Evan indicated that when they could not find the necessary information on the digital literacy resource pages, they searched online to find information until they could answer the guiding questions adequately. In summary, through the process of co-building knowledge of digital literacies and co-creating a class Web site and video commercials for their chosen tools, participants showed improved skills in using technology to interact with each other and creating, designing, and publishing digital content. In addition, through the culmination product—the published Web site, which included the explanation sections, video commercials for their chosen tools, and lesson plans—participants successfully joined a participatory culture through adopting a collective identity as professional educators. They also used their existing skills of conducting research to accomplish the goal of the TGP. In addition to growth in participants' digital literacies skills, the data indicated they learned how to integrate technology into education, which I explain in the following section.

Theme 3: Improved Knowledge regarding Technology Integration in Education

As discussed in earlier chapters, students in technology integration courses can benefit from learning how to integrate digital tools meaningfully into education. Therefore, student groups from Classes A, B, and C were expected to build knowledge of integrating technology into education by completing individual assignments and co-creating their group's lesson plan. The data from the field notes, group interviews, individual knowledge building (IKB) assignments, and participant groups' lesson plans indicated the growth of participants' knowledge of integrating technology into education. However, across the groups, there were differences in their quality of lesson plans in terms of their meaningfulness (see Howland et al., 2012)

Observation and participant products. Among the 10 phases of the TGP, students engaged in designing lesson plans from phases 6 to 7. Table 5-18 presents the observed moments of participants' learning of technology integration into education.

Table 5-18

Observed Moments of Learning Technology Integration into Education during the TGP

<table>
<tr><th>Phases</th><th>Topic</th><th>Observed Moments of Learning Technology Integration into Education</th></tr>
<tr><td>6 to 7</td><td>Lesson plan design</td><td>

• **Learning how to design lesson plans**

-I found that students in Classes B and C did not have experiences in creating lesson plans. They needed a lot of guidance about selecting subjects, finding adequate Georgia standards, using technologies for activities, and writing activity descriptions in their lesson plans. I communicated what I observed with Antonio and suggested giving the following instructions to his students.

1. Show the sample lesson plan through the Model/Guidance Web site.
2. Show the Georgia state standards Web site.
3. Guide students to use the tool they advertise through their video commercials in their lesson plans as one of the technologies so that the three sections of each webpage are organically connected.

- The collaboration group from class A actively discussed what to teach through their lesson plan. While they were discussing the activity description section of their lesson plan, they were completing their lesson plan sections on the Google Docs worksheet.

- I helped the digital citizenship groups from Classes A (Antonio's class) and B (one of my classes) to find the necessary resources for designing their lesson plans by suggesting searching resources with the keywords: *Georgia state standards, digital citizenship*.

- Students from class B were very active in creating lesson plans. I explained how to create lesson plans and showed the sample lesson plan. In addition, I explained that they did not necessarily need to follow the unit-based lesson plan shown in the sample lesson plan. Instead, they were told that they could choose to create a class-period lesson plan instead of lesson plans composed of units.

- I walked around continually in Class C to guide their work on lesson plans. I felt that without my guidance, their work could be inadequate. However, their discussions regarding the lesson plan design were active.

</td></tr>
</table>

A lesson plan template, a sample lesson plan, and exemplary lesson activity resources were provided for students so that they could create their lesson plans following the template, worked example of the lesson plan, and activity resources. As shown in Table 5-18, the students from my classes (Classes B and C) needed detailed guidance regarding completing the lesson plan components such as subject, technology, and the Georgia state standards in each subject area.

Therefore, as shown in Table 5-18, I communicated what I experienced in my classes to Antonio and shared my opinions about how to use the resources such as the sample lesson plan and Georgia state standards Web site to help his students have a better understanding of creating lesson plans. Participants from Class A also had questions about the components of the lesson plan such as subject, technology, grade, and activity description. Participants were guided in selecting one of the K-12 subjects, using the tool they advertised in the video commercials for their chosen tools, targeting one of the K-12 grades, integrating technologies meaningfully, and including at least one unit in their activity description section.

Some groups of participants from Classes A, B, and C needed the instructors' assistance regarding tasks related to creating lesson plans, such as deciding on specific standards, finding resources, integrating technologies meaningfully, and organizing activities, as shown in Table 5-18. For example, the digital citizenship group from Classes A (Antonio's class) and B (one of my classes) had difficulties in finding related Georgia state standards and resources, and I recommended searching Google using keywords such as "Georgia state standards and digital citizenship." This assistance helped the group proceed with creating lesson plans. Some groups were very good at producing ideas for their lesson plans. For example, the creating and publishing group from Class A suggested using a 3D modeling tool (Tinkercad), Google Slides, and Prezi to teach human cell parts (see Appendix Q1). Their ideas were good examples of ideas on using technologies in terms of the five elements of meaningful learning with technology suggested in Howland et al. (2012).

However, when I initially reviewed student groups' lesson plans, I found that most groups had a misunderstanding about meaningful integration with technology. They focused on using technologies for lessons without considering the meaningfulness of using technologies for the activities. Therefore, I provided feedback on their lesson plans asking the students to review Howland et al. (2012) once more and review their lesson plans. Antonio also provided feedback on the lesson plans. Table 5-19 shows what Antonio (Class A) and I (Classes B and C) suggested to the participant groups to improve their lesson plans.

Table 5-19

Instructors' Feedback on Lesson Plans

Group	Class A	Class B	Class C
Communication	Offer concrete and specific information regarding resources and activity procedure.	Modify current activities so that VoiceThread can be used meaningfully.	It is true that you can communicate subject content through Kahoot. However, Kahoot is not specifically for communication. Therefore, use Kahoot for gamification of the lesson.
Collaboration	Collaborative nature of using the smartboard technology is not clear. Therefore, design meaningful collaborative activities.	Go beyond the virtual field to nearby places, allow your learners to visit distant countries from other continents such as Africa and Asia and construct their knowledge based on the trip.	Rather than focusing on teaching the learners how to use Google Drive, focus on teaching physics concepts using Google Drive.
Creating / Publishing	The activities using Tinkercad seem complex for 7th grade learners.	Excellent job at incorporating Tinkercad and Thingiverse for teaching the solar system.	Allow learners to create Web sites collaboratively rather than individually.
Digital Citizenship	Develop 5 weeks of activities as planned initially.	Go beyond delivering information with BrainPOP. Instead, allow your students to construct their knowledge of digital citizenship.	Let learners build knowledge of digital citizenship through the Remind application.
Research	Provide step-by-step activity descriptions so that other educators can easily understand the processes.	After learners collect resources through Pinterest, let students construct knowledge together.	Allow learners to go from collecting resources about the Great Depression to building knowledge together.
Problem solving	(Antonio's feedback was not found, but this group's lesson plan was excellent)	Microbit is usually not an adequate tool for solving real-life problems, so focus on improving learners' computational thinking capabilities with Microbit.	Excellent job at creating Ozobot Olympics.

As shown in Table 5-19, most groups needed instructors' scaffolding regarding designing their lesson plans. Antonio suggested that each group except for the problem-solving group create more adequate lesson plans or substantiate their lesson plans by offering more detailed description or resources. I also suggested that each group strengthen the aspects of meaningful learning with technology except for the problem-solving group, whose lesson plan was meaningful enough. Based on my observation and participant groups' work, participants needed relatively more guidance to create lesson plans as opposed to the explanation sections and video commercials for their chosen tools. Despite instructors' feedback on their lesson plans, some participant groups did not modify their lesson plans. This resulted in their final lesson plans being less meaningfulness according to Howland's (2012) meaningfulness criteria, as shown in the following section.

Collaborative knowledge building (CKB). Individual knowledge building (IKB) assignments, which are presented in the next section, offered a basis for students' collaborative activities of creating lesson plans. All the groups from Classes A, B, and C managed to create their groups' lesson plans. As mentioned earlier, some participants had difficulties in locating specific Georgia state standards for lesson plans. In addition, the initial quality of the lesson plans was not satisfactory because technologies were not used meaningfully. Antonio and I reminded the students of the five elements of meaningful learning—active, constructive, cooperative, authentic, and intentional (Howland et al., 2012)—and asked them to incorporate technologies meaningfully into the activities shown in their lesson plans. 11 groups (Class A: 4 groups and Classes B and C: 7 groups) out of 18 groups in total created lesson plans in which technologies were meaningfully integrated. However, it was difficult to find meaningfulness in the other 7 groups' lesson plans.

For example, among the lesson plans shown in Table 5-20, the lesson plans of the communication group, creating and publishing group (see Appendix Q1 for this group's lesson plan), research group, and problem-solving group demonstrated the elements of meaningful learning with technology (Howland et al., 2012), such as active learning, constructive learning, collaborative learning, and intentional learning. However, the lesson plans of the collaboration group and digital citizen group did not clearly show the elements of meaningful learning with technology (Howland et al., 2012). For example, in the collaboration group's lesson plan, it was difficult to understand why the smartboard was being used. In addition, the Class123 classroom management tool was being used not for students' learning activities but for sharing photos with parents.

Table 5-20

Summary of Lesson Plans of Class A Participants

Digital Literacy	Subject	Grade	Technologies	Meaningfulness	Activity
Communication	Language Arts	9	Google Slides, GroupMe	**Active/ Constructive/ Collaborative**	Exchanging thoughts about cultural content shown in short stories through GroupMe and co-constructing their cultural knowledge
Collaboration	Math	K	Class123, Smartboard	No clear indication that Class123 and Smartboard were being used for collaboration	Writing numbers on the smartboard after counting assorted pom-pom balls in groups/Sharing the activity photos and videos through Class123
Creating & Publishing	Science	7	Tinkercad, Google Slides & Prezi	**Intentional/ Constructive/ Active**	Designing a 3D model of human cell parts /Constructing knowledge of human cell parts
Digital Citizenship	Business	11 / 12	Social media	Incomplete activity description	Creating digital profiles/Posting content to social media platforms
Research	Science	8	Pinterest	**Active/ Constructive**	Researching scientific experiments and collecting them through Pinterest online pin board/Presenting their research through PowerPoint or videos
Problem solving	Computer Science	6	CodeMonkey, Google Slides	**Active/ Constructive**	Block coding through CodeMonkey/Presenting what they learned in terms of coding and problem solving

Note. The elements of meaningful learning (Howland et al., 2012) are in bold.

Regarding the lesson plans of Class B participants, shown in Table 5-21, the lesson plan of the problem-solving group seemed relatively less meaningful. However, other participant groups from Class B created lesson plans in which technologies were being used meaningfully. For example, the collaboration group (see Appendix Q2 for this group's lesson plan) incorporated multiple tools such as Google Earth, Google Maps, Google Docs, and Google Slides to teach world geography to middle school students. Their lesson plan provided students with opportunities to go to virtual field trips around the world, co-construct their geographical knowledge on Google Docs, and present their findings to their classmates through Google Slides. Their lesson plan was meaningful because students are expected to actively and collaboratively construct their knowledge of world geography.

Table 5-21

Summary of Lesson Plans of Class B Participants

Digital Literacy	Subject	Grade	Technologies	Meaningfulness	Activity
Communication	History	5	VoiceThread, YouTube, Google Slides	**Active/ Intentional/ Collaborative/ Constructive**	Watching YouTube videos regarding World War II/VoiceThread discussion about questions given to them
Collaboration	Social Studies	6-7	Google Earth, Google Maps, Google Docs, Google Slides	**Active/ Intentional/ Collaborative/ Constructive**	Virtual field trip around the world in groups/Researching the specific areas / Presenting their research
Creating & Publishing	Science	4	Tinkercad & Thingiverse	**Active/ Intentional/ Collaborative/ Constructive**	Researching the attributes of specific planets in groups/Designing a 3D model of the planets/Publishing their 3D model
Digital Citizenship	Computer Science	4	BrainPOP, Google Docs, Google Slides, Padlet	**Active/ Intentional/ Collaborative/ Constructive**	Creating drawings of students' digital footprint/Learning digital citizenship/Presenting different components of digital citizenship
Research	Social studies	4	Pinterest, Diigo, MindMeister, Google Slides	**Active/ Intentional/ Collaborative/ Constructive**	Researching natural rights and sharing the collected resources through Diigo/Visualizing different government powers through MindMeister/Creating a Pinterest board to share their findings/Presenting their study through Google Slides
Problem solving	Computer science	4	Microbit	This is an active learning activity, but the activities are not clearly connected to achieve the goal of the lesson.	Completing the Crash Bird assignment on the Microbit Web site in groups

Note. The elements of meaningful learning (Howland et al., 2012) are in bold.

Regarding the lesson plan of the problem-solving group (Class B) (see Table 5-21), the technology Microbit (micro computers) and the coding activities in the lesson plan seemed adequate for improving their computational thinking capabilities. However, it was not clear how the technology and coding activities could help them improve the design thinking capabilities they intended to improve, even though the lesson plan indicated the element of active learning. In other group's lesson plans from Class B, as shown in Table 5-21, technology contributed to organizing active, intentional, collaborative, and constructive learning in their lesson plans (Howland et al., 2012).

Regarding participants' lesson plans from Class C, the lesson plans of the research and problem-solving group demonstrated meaningful integration of technology, as shown in Table 5-22. In the research group's lesson plan (see Appendix Q3), technologies such as Pinterest, Evernote, and PowerPoint were incorporated meaningfully because they were clearly being used to help students achieve the goal of learning about the Great Depression through their active and constructive learning. However, the other groups' lesson plans were relatively less meaningful. For example, the communication group's lesson plan did not clearly show how Top Hat and Kahoot could be used for communication digital literacy practices except for checking students' attendance and gamifying math activities. In addition, Google Docs in the collaboration group's lesson plan did not seem to meaningfully support physics learning.

Table 5-22

Summary of Lesson Plans of Class C Participants

Digital Literacy	Subject	Grade	Technologies	Meaningfulness	Activity
Communication	Math	2	Kahoot and Top Hat	The usage of Top Hat and Kahoot is not clearly associated with communication	Learning math through Kahoot games
Collaboration	Physics	6	Google Drive	It is not clearly explained how Google Docs could facilitate physics learning	Learning physics problems together through Google Docs
Creating & Publishing	Language arts	9-12	Google Sites	It is not clearly described how Google Sites could facilitate students' learning	Expressing themselves through Google Sites
Digital Citizenship	Social Science	6-8	GroupMe	GroupMe is not being actively used in this lesson	Showing modeled examples of digital citizenship through GroupMe
Research	Social Studies	5	Pinterest, Evernote, PowerPoint	**Active/ Collaborative/ Constructive/ Intentional**	Researching the Great Depression / Managing their findings through Evernote / Using Pinterest for collecting image resources / Co-constructing of knowledge and presenting
Problem solving	Career and Technical Education	9	Blockly, Ozobot	**Active, collaborative**	Learning block programming / Competing in Ozobot Olympics

Note. The elements of meaningful learning (Howland et al., 2012) are in bold.

Collaborative knowledge building (CKB) activities revealed that some lesson plans needed improvement in terms of *meaningful learning with technology*. Although there were participant groups which revealed their lack of knowledge of integrating technology meaningfully, the data from the individual assignments indicated participants' knowledge regarding technology integration in education as shown in the following section.

Individual knowledge building (IKB) in Class A. Students from Classes A, B, and C were expected to answer questions about using technology for education based on the digital literacy resources provided to them. Some students shared brief ideas of using technology, and others submitted relatively detailed thoughts. For example, regarding teaching *research* digital literacy practice, Jenna (A) wrote:

> From the TED Talks, the man described putting computers filled with information in English in villages that did not speak English. The results amazed him with that the children, without the help of adults, taught themselves how to use the computers, English, and the information that was on the computer. These results show that we can give students information on certain technological devices filled with information, and they can learn and teach themselves by exploring independently.

After watching the TED Talks video "Build a School in the Cloud," which was about allowing learners to lead independent and social learning through computers, Jenna shared her ideas of helping students learn independently with the help of technologies. Her response indicated that she had the knowledge of designing learning environments in which learners can conduct research and construct knowledge independently with the help of technology. On teaching *creating* and *publishing* digital literacy practices, Kasha responded in a relatively long paragraph that:

> Firstly, students should be comfortable and well educated on the creation spaces they are using. That way they know all the tools to ensure they are producing quality content. I would strive to use a tool where it is private, and their own information cannot be published for their own safety while still learning the application. There is a component of digital responsibility that would need to be discussed as any content created can be found somewhere on the internet or just seen by an instructor/other students. And so, students need to know what is and isn't appropriate to post (also relating to the topic of the content being created) and how to avoid publishing content that does not go inline with what is being asked of them to create. I think that using a few different spaces at first may be helpful so that students can find what works for them and what they understand and how to navigate through each of the sites so they can master each kind and continue to use them even after the assignment. Having example pieces of work would be beneficial too so that the students can visualize what their space should look like and what the expectations are for the final piece of work being published. Overall,

> having clear visuals and opportunities to practice with the sites will greatly improve a student's ability to become an adequate creator and publisher.

Kasha (A) indicated that she understood that publishing practices are closely associated with establishing digital citizenship. For example, she mentioned that she would choose publishing tools which provide private settings before publishing so that she could keep students from publishing unwanted content when they learn how to use the publishing tools. Therefore, even though the topic is about teaching creating and publishing digital literacy to K-12 students, she mentioned the importance of teaching topics related to digital citizenship before guiding students to create and publish digital content. In addition, she revealed her pedagogical knowledge of using worked examples, such as created Web sites, to support students' creating and publishing activities.

Individual knowledge building (IKB) in Classes B and C. Like the participants from Class A, participants from Classes B and C presented their ideas of teaching K-12 students with technologies. For example, on teaching problem solving, Amy (B) responded that:

> In order to help K-12 students solve problems with computational thinking and design thinking, we will go through all the steps. I will present the students with a problem or idea and ask them to use a tool like Evernote to write down things they might already know about this problem or idea. They will research the problem and use a tool like OKMindmap, MindMeister, or Prezi to present ideas on how to test or experiment with this problem to find a solution. Then we can use that same tool to show the solutions at the end and how their perspectives on the problem have changed. Ultimately, they will have shown what they know about the problem initially, how to test or solve this problem, and what they have learned as a result or what "design" came out of it.

Amy, showing her understanding of *problem-solving* digital literacy practice, suggested using multiple tools such as Evernote, OKMindmap, MindMeister or Prezi for presenting problems, conducting research, or presenting ideas for solving the problems. She indicated that she could organize learning activities in which learners recognize problems and provide solutions to the problems by employing design thinking and computational thinking capabilities. In addition, regarding implementing collaborative work with technologies, Melinda (C) responded that:

> In a K-12 setting, students can use Google Docs to work together on projects and share ideas with each other. One activity that could be used in a K-12 setting would be a research paper where each student has a different assignment, but they all post it into the same Google Docs. This would allow students to work independently while also collaborating with their classmates.

Melinda clearly indicated that she understood how Google Docs works. Furthermore, she showed that she could organize individual and collaborative learning activities in which learners can contribute to each others' learning by using the technological affordances of Google Docs. Similarly, Amanda (C) wrote:

> Collaboration activities using Padlet and Google Docs can be used in a fun and creative way for K-12 students. Padlet will allow students to create their own projects and then put them up for other students to utilize and learn. Google Docs are especially beneficial for students in high school as they will be utilizing this in college. This will allow students to collaborate and edit their projects.

Amanda described her ideas of how Padlet online walls can be used to facilitate social learning. In addition, she was also well aware of the features of Google Docs, which makes collaborative editing possible. Therefore, she indicated that she could design collaborative learning activities using the technological affordances of Padlet online walls and collaborative online word processing tools such as Google Docs. The data from participants' individual knowledge building (IKB) activities indicated participants' digital literacies of incorporating technologies into education. Group interviews with the participants also revealed improved knowledge in terms of technology integration into education as shown in the following section.

Group interviews with participants from Class A. Participants from Class A engaged in creating their group's lesson plans to share their knowledge of integrating technologies meaningfully into education. In a group interview, Andrea (A) stated, "…the hardest part was finding the standards just because there's so much to dig through…” As she indicated, some participants had difficulties in choosing specific Georgia state standards they found adequate. However, once they selected standards, they could create lesson plans in which they integrated technologies to achieve specific objectives. In a group interview, Amanda (A) stated:

> Um so personally for me I was in an early childhood education program back in my high school and so like coming up with a lesson plan like was it really like something new to me. So I was just kind of like, “Oh, cool!” Standard, objective, like and details about it, but I feel like after especially after we had like come up with like our idea for the video and like we just kind of really okay, how can we apply it to the classroom like actually and a lesson plan. Mmm, so we don't really think it was that bad. We thought we found standards that were very relevant to code, to like using CodeMonkey and we thought it could be like you know you can apply like like active learning and communication collaboration all of that like within that activity.

Amanda’s group created a lesson plan in which they intended to improve the computational thinking capability of 6th grade learners. She mentioned it was a new experience for her to create a lesson plan. She indicated that she learned how to connect Georgia state standards to their lesson plan, implement their ideas in lesson plan activities, and realize the elements of meaningful learning such as active learning and collaborative learning in their lesson plan. Amelia (A) also responded that:

> I think just learning how to like incorporate technology into like we used it for teaching, but um we both want to be speech pathologist. So, I think incorporating that into our future careers is pretty cool, and like we learned how to do that.

Amelia indicated that she learned how to use technology for teaching and expected that what she learned on how to use technology in education would be helpful for her future career as a speech pathologist. Amelia’s response indicated the growth of knowledge in technology integration into education. Group interview participants from Classes B and C also showed growth in the knowledge of using technology for education as shown in the following section.

Group interviews with participants from Classes B and C. Similar to participants from Class A, those from Classes B and C also engaged in creating lesson plans together. Creating lesson plans was not a familiar experience for some students. Therefore, some participants had to put themselves into the position of an educator to create lesson plans. For example, James and Nadin (B) responded as follows:

> **James**: Mmm, I guess working with the objectives thinking about being an educator that mindset versus student mindset just how we could take this idea and these resources and lessons that we've learned turned that into something useful.
> **Nadin**: Yeah, I think it just made us that you have to think outside the box a little bit because like he James said, we had to like take the standards and the objectives and everything and kind of make something out of that.
> …
> **Nadin**: I feel like definitely incorporate technology more into like just their day-to-day like activities and everything because I know like when we were younger, technology wasn't like as big of being as it is now. So, I feel like you know just day-to-day activities they can like get like the little laptops that they have and like do like easy activities and use the tools that some of the tools that we learned to do those kind of activities such as like you know an interactive video. They can use those and other you know different tools and kind of just like seamlessly incorporate that into like everyday lessons.

James and Nadin shared their experiences of thinking from the perspective of educators, which were not familiar roles to them. They indicated that they learned how to set up objectives and utilize their ideas and available resources to create useful lessons. Furthermore, Nadin showed her vision of using technologies, such as the interactive video tools she learned how to use during the course. In addition, regarding my question about their experiences in creating their group's lesson plan, Megan and Luke (C) responded as follows:

> **Megan**: Oh yeah, that was interesting to look at all that. I had never looked at because I'm not education. So, I've never done anything with education, but doing the looking at the standards, the Georgia standards, it was really interesting too_
> **Luke**: Yeah
> **Megan**: _Connecting like our idea of what was our specific?
> **Luke**: Ours was Ozobot Olympics.
> **Megan**: Ha ha Ozobot. Doing something like that and connecting to how to connect like our idea with like standards or using the Georgia standard, the education standards to

> connect with things. You could teach more students and that was really interesting because I've never since I'm a business major, I've never never thought about that ever.
> **Luke**: From, from what I remember I think it was kind of like me and Lisa kind of like flesh out the idea of just like like what it would look like in the classroom. I'm like how like students would like enjoy the like thing and like have fun and like also kind of like the steps and then AVA and MEGAN kind of did like yeah I did the Georgia standards implemented those and helped like revised our plan.

Megan and Luke shared their collaborative learning experiences in creating their group's lesson plan. As Megan stated, it was a new experience for some of the participants. They needed to conduct research to find suitable Georgia state standards and connect their ideas to the chosen standards. Furthermore, Luke indicated that they collaborated to create the lesson plans by combining each other's ideas and efforts. As a result, the group produced their groups' lesson plan, in which the Ozobot robotics platform was used to improve the computational thinking capabilities of grade 9 learners.

The final theme regarding the first research question emerged with regard to students' attitudes toward learning digital literacies and is described in the next section.

Theme 4: Positive Attitudes toward Digital Literacies and Enjoyment of the TGP

The TGP was focused on facilitating students' digital literacies so that they could help K-12 students improve their literacies in the future. In the middle of the TGP, as a part of Tech force/Model lesson activities, I investigated the students' attitudes toward teaching digital literacies for K-12 students. I asked them how they would respond to a student's opinion below, which showed an attitude arguing against digital literacy education (Kist & Pytash, 2015), through the Mentimeter anonymous interactive response application:

> "I see smart teachers, doctors, lawyers and business professionals who got where they are today without the help of any kind of technology or multimodal literacy. They were

brought up with the basics—Reading, Writing and Arithmetic." (A student's reflection regarding digital literacy education shown in Kist & Pytash (2015, p, 144))

As shown in Table 5-23, a majority of the participant responses (more than 80%) were positive toward teaching digital literacies to K-12 students (see Appendix R for the full Mentimeter responses of participants).

Table 5-23

Participants' Attitudes toward Digital Literacy Education

Classes	Positive	Negative	Total
A	7	1	8
B and C	33	3	36

For example, a participant responded:

> It would be very beneficial for K-12 students to learn how to communicate, collaborate, create, publish, research, and solve problems with technologies as well as establish adequate digital citizenship. Technology helps students better themselves.

This indicated that this student recognized the necessity of teaching digital literacy practices to K-12 students. In addition, this student indicated his or her knowledge of digital literacy practices by mentioning all the six digital literacy practices in the response. However, several participants displayed negative attitudes toward digital literacy education. For example, a participant stated:

> I would love to think that people can still do big things without relying on technology. I do not like to think that this day and age has become so dependent on technology that a person is unable to accomplish their goals without it.

This student indicated some concerns about overdependence on technology. In addition, the student revealed his or her thoughts that people can still achieve their goals without technology, which indicated her cautions about overdependency on technology. However, the number of negative responses like this was small, and most participants recognized the importance of digital literacy education, which was the intent of the TGP. In addition, the data from the open-ended question (Q 15) from the post-survey indicated that students were motivated to study more about digital literacies. As Table 5-24 indicates, the list of students' answers (see Appendix S for the full list of the responses) to the open-ended question indicated that the majority of the participants (58 among 61 students) were motivated to learn more about digital literacies after completing the TGP. The positive responses were diverse, from simply saying that they want to learn digital literacy more and to indicating the importance of learning digital literacies in terms of their future jobs and K-12 education. Some participant responses revealed that they gained digital literacy knowledge, learned new tools through the TGP, and enjoyed the TGP. However, three students stated that they were not interested in learning more due to having no interest, having an already high level of digital literacies, and cautions about increasing technology use.

Table 5-24

Response Examples to the Open-Ended Question Regarding Learning More about Digital Literacies from the Post-survey

Class A
- I think it is very important because it is beneficial to know how to communicate digitally in our day and age. - I've learned a lot through this project but would be interested in learning more before I graduate. - I am currently motivated to learn more about digital citizenship because it plays a large role in your life as you begin to search for a career.
Classes B and C
- I want to understand more advanced programming in the future. This class has encouraged me to want to learn more about this. - I believe I have learned so much about digital literacy throughout the past couple of weeks and I am excited to learn more. - I am very motivated because of this class I have learned about new sites as resources that I've never heard of. - Very motivated, before this class I knew very little about tech. Now I can't wait to learn more. - I am very motivated due to the fact that this knowledge will help me as a student and a future educator. - I am really enjoying learning more about digital literacy.

In addition to being motivated to learn more about digital literacy, most participants (more than 50%) indicated no concerns about learning more about digital literacies on the post-survey open-ended question (Q 16). However, there were participants who indicated their concerns about learning digital literacies, as shown in Table 5-25. For example, similar to the responses in the pre-survey, they had diverse concerns, such as too much dependency on technology, health issues, lack of skills, and lack of knowledge about further learning paths.

Table 5-25

Response Examples to the Open-Ended Question regarding Participants' Concerns on the Post-survey

Class A
- I am not sure what new communication platforms I should experiment with. - I think my biggest concern is learning the crucial software that not many know - Sometimes I struggle when learning how to work new technology; therefore, my only concern is that I will not know how to use new technology that I am introduced to.
Classes B and C
- Not being able to keep up with the pace. - I'm worried that as communication through technology improves, other forms of communication will be weakened. - I am concerned about my skills using technology. - Students may become too dependent on technology. - where to go from here - I don't want to mess with my eye and head from getting dependent on computers. - That student become too dependent on technology. - My only concern is that technology may take over life.

In addition to participants' positive attitudes toward digital literacy education, group interviews with students from Classes A, B, and C indicated that participants generally enjoyed the TGP.

Group interviews with participants from Class A. Regarding the interview questions regarding their opinions about the TGP, Andrea (A) said, "Um I enjoyed it. I learned a lot about kind of the different tools that you use…" Andrea indicated that she enjoyed the TGP because she could learn diverse tools. Similarly, Emma and Amelia (A) responded as follows:

> **Emma**: It was pretty good. Yeah.
> **Amelia**: I enjoyed it.
> …
> **Amelia**: I feel like I learned a lot more about how to use technology, and I didn't really know all the aspects of it beforehand. So, I felt like that helped me to learn more about it.

Emma and Amelia participated in the TGP very actively and indicated that they had positive feelings about the TGP. In addition, Amelia stated that her knowledge of using technology improved and indicated that she learned different aspects of technology, which I interpret as diverse digital literacy practices. In addition to participants' enjoyment of the TGP, interview responses indicated the technology in the TGP was easy to use. For example, Amanda said, "…using Google Sites was very helpful very easy and efficient." Amanda (A) indicated that it was easy and helpful to create and publish Web sites using the new Google Sites platform. In addition, regarding their experiences in creating video commercials, Emma (A) stated, "It was pretty easy." These responses indicated that the TGP was enjoyable and the technology was easy to use during the TGP.

Interview participants from Classes B and C indicated similar feelings as shown in the following section.

Group interviews with participants from Classes B and C. Similar to interview participants from Class A, interview participants from Classes B and C displayed positive feelings about the TGP. For example, Jane (B) and Rachel (C) responded as follows:

> **Jane** (B): I really enjoy your class. Like it, this is one of my favorite class.
>
> **Rachel** (C): I guess I really enjoyed it. At first, I was just like why does he have me doing this, but it really made sense afterwards, and I did gain a lot from it.

Jane and Rachel mentioned that they enjoyed the course activities. In addition, Rachel described her positive learning experiences in participating in the TGP. Gina from the creating and publishing group of Class C also said, "I liked it. I like how interactive it was, mmm, how like it was never like busy work. It seemed like we were doing something. We were learning at the same time." She indicated that she liked the interactive aspects of the TGP and active learning experiences during the TGP. When I interviewed the participants, I recognized that they especially enjoyed creating video commercials for their chosen tools. Whenever I asked about their experiences in creating videos, almost all the groups of participants shared their stories while laughing together as shown in the following interview with Sophia, Anne, and Jane (B):

> **All**: Hahaha. That was fun. That was fun.
> **Sophia**: We had to share the space with somebody. So, it was a little difficult at first because they had to take turns videoing and like with another group, but that was fine, but we worked really well. We had to redo parts sections over and over again because they kept messing up on our script.
> **Anne**: We were laughing.
> **Jane**: It was fun.

Sophia, Anne, and Jane indicated that it was fun to create video commercials besides the space issue they experienced while they were recording. In addition, interview responses also indicated that using technology in the TGP was easy. For example, regarding her experiences with creating the Web site, Nadin (B) said:

> I thought it was cool. I've never done that before. I've never created a webpage before. So, I feel like it was very useful because in the future if I wanted to ever do that, mmm, I found it pretty like simple.

Nadin indicated that creating webpages was easy and simple even though she had never created any webpages before. She also indicated that the technologies learned in the TGP was useful because she could now create webpages. Similarly, regarding his experiences in creating a class Web site, Evan (C) said, “Umm, being able to like edit the website at the same time made it easy to cuz like since we each kind of concentrated on a section.” Evan’s response indicated that the collaborative feature of new Google Sites helped his group work together to complete its webpage with ease.

So far in this section, I presented the results from the pre- and post-surveys and findings which emerged from the qualitative data regarding the first research question. The results and findings mainly indicated growth in participants’ digital literacy knowledge and skills as well as pedagogical knowledge of technology integration. In addition, the Menitmeter responses and participants' responses to the open-ended question indicated participants' generally positive attitudes towards digital literacies. Finally, interview responses indicated that the TGP was enjoyable and that the technology in the TGP was easy and useful.

In the next chapter, I will focus on the data which demonstrated the role of diverse scaffolds in students' collaborative work in association with the second research question.

CHAPTER 6

CONCLUSION

In this mixed-methods study, a CSCL environment was designed to help improve undergraduate students' digital literacies in technology integration courses with multiple scaffolds: collaboration guides, question prompts, digital literacy resources, and popular-culture resources. The multiple scaffolds were systematically provided to the undergraduate students to help them participate in authentic digital literacy practices in CSCL. The TGP focused on helping students communicate their digital literacy knowledge to educators around the world through the participation in digital literacy practices. Therefore, this study aimed to explore the role of the multiple scaffolds in the CSCL environment and students' digital literacies shown in technology integration courses. Students from three classes (Antonio's class: Class A, n=20; my classes: Classes B and C, n = 20 and 21, respectively) participated in digital literacy practices of publishing each class Web site to share their digital literacy knowledge with K-12 educators around the world.

The results and findings from quantitative and qualitative data indicated that the TGP contributed to improving participiptants' digital literacy competency. The results from quantitative data also indicated that the participants from all the classes had improved digital literacy attitudes toward K-12 education. The findings from quantitative data indicated that participants had positive attitudes toward digital literacy education In addition, the data indicated that the participants found that the multiple scaffolds were useful for collaborative work or digital literacy learning. P In the next section, I discuss primary interpretations of the results and findings with regard to the two research questions with theoretical deliberations.

Overall Interpretation of Results and Findings

The results and findings in this study indicated that students in technology integration courses can benefit from CSCL environments regarding improving digital literacy knowledge, skills, and attitudes as well as pedagogical knowledge of integrating technology meaningfully into K-12 classrooms. In addition, the results and findings revealed that students' digital literacy learning in technology integration courses can be facilitated by instructional scaffolds such as collaboration guides, question prompts, digital literacy resources, and popular-culture resources. The overall interpretation with regard to the first research questions is presented in the next section.

RQ1: How do the Instructional Scaffolds—Collaboration Guides, Question Prompts Digital Literacy Resources, and Popular-Culture Resources—Support Collaborative Activities during the Technology Genius Project

In this section, I interpret the results and findings associated with the supporting role of the multiple scaffolds in CSCL.

Validation of CSCL environments for digital literacy education. As discussed in the literature review section, CSCL environments have common elements with digital literacy practices because both of them put emphasis on communication and collaboration with the help of computers. Therefore, CSCL environments were proposed as a learning environment to facilitate students' digital literacy development in technology integration courses in this study. However, there has been a lack of research regarding CSCL environments as a legitimate learning environment for students in technology integration courses, although CSCL environments can support students' communicative digital literacy practices and collaborative knowledge building activities with multiple scaffolds and computers.

First, as discussed in an earlier chapter, the legitimacy of CSCL environments for supporting students' digital literacy development in technology integration courses can be found in the nature of Web 2.0 environments and CSCL environments. The communicative, interactive, and participatory nature of Web 2.0 environment (Jenkins et al., 2015; Lotherington & Jenson, 2011; Meyers et al., 2013; Wang & Mu, 2017) and collaborative, constructive, and technology-friendly nature of CSCL (Jeong & Hmelo-Silver, 2016; Wang & Mu, 2017) can be well coordinated. In addition, multiple digital literacy frameworks have all indicated the importance of communication and collaboration (Ferrari, 2013; ISTE, 2016; ISTE, 2017; Reynolds, 2016). The interactive aspects of Web 2.0 and the emphasis of multiple digital literacy frameworks on communication and collaboration suggest the possibility that CSCL learning environments can facilitate digital literacy development because CSCL environments focus on how to support learners' collaborative interaction and learning with media and technology.

In addition, as mentioned earlier, the potential of CSCL environments for undergraduate students' digital literacy development in technology integration courses can be also found in the *learning by design* approach (Koehler & Mishra, 2005) as a way of improving educators' TPACK. The *learning by design* approach emphasized collaborative learning to facilitate problem-solving processes (see Agyei & Voogt, 2012; Koehler, Mishra, & Yahya, 2007; Johnson, 2012; Mouza et al., 2014). This emphasis on the collaborative learning indicates that collaborative learning environments can contribute to learners finding effective solutions to using technology adequately in classrooms (Baran & Uygun, 2016).

Therefore, I designed a CSCL environment for students in technology integration courses based on the definition of a CSCL environment as being “a learning environment in which a large amount of information can be accessed easily, and in which knowledge can be shared and co-constructed through communication and joint construction of products” (O’Donnell et al., 2013, p. 266). During the TGP, the students co-constructed their knowledge of digital literacy practices by implementing digital literacy practices such as conducting research and designing, creating, and publishing webpages, video commercials, and lesson plans. The results and findings indicated that the designed CSCL environment offered communicative and collaborative learning environments to within-group members as well as between-group members through the support of computers, mobile devices, multiple scaffolds, and digital tools such as Google Docs and new Google Sites.

The results and findings from the post-survey and the group interviews indicated that participants in general learned from each other, found the multiple scaffolds helpful, and enjoyed collaborating with other students during the TGP. These results and findings validated Vygotsky’s (1978) socio-cultural theory, which suggests that social interaction mediates learners’ knowledge construction. However, collaboration in learning environments does not happen often in many classrooms (Kirschner & Erkens, 2013; Kollar et al., 2006; Wang & Mu, 2017). Therefore, the TGP was designed to support collaborative learning with the multiple scaffolds. The results and findings also validated the supporting role of collaboration guides (Kollar et al., 2006; Wang & Mu, 2017), question prompts (Ge & Land, 2004; Miller & Hadwin, 2015), and resources (Jeong & Hmelo-Silver, 2016) for collaborative learning. In addition, the results and findings indicated the popular culture (Alvermann, 2012; Lawrence et al., 2009; Pryor, 2008) can be relatable resources to support students’ digital literacy learning in technology integration courses. In summary, the results and findings indicated that students' digital literacy development can facilitated in CSCL environments with the support of diverse scaffolds.

Role and design of the collaboration guides. In this study, collaboration guides supported collaborative learning processes by specifying phases, tasks, groups, modes, and the duration of collaboration according to the CSCL script specifications shown in Dillenbourg (2002). In general, interview participants and the responses to the open-ended question on the post-survey indicated that collaboration guides were useful for their collaborative learning. These findings validated the claim that collaboration guides can support collaborative learning by offering guidance for collaboration (Kobbe et al., 2007; Wang & Mu, 2017).

However, at the initial stages of the TGP, some participants were confused about the collaboration guides because they could not see the purpose of specific activities in relation to the final products: webpages, video commercials, and lesson plans. In addition, as mentioned earlier, the timing of activities in Class A did not work as intended. Finally, the group formation method in Class A seemed to need reconsideration because of the disengagement of some students. These findings indicated the necessity of clearly communicating learning objectives in CSCL, which is one of the components of collaboration guides in Kollar et al. (2006), as well as specifying collaboration guides meticulously with regard to phases, tasks, group, mode, and duration of collaboration (Dillenbourg, 2002).

In this study, the macro scripts (see Hernandez-Leo et al., 2006; Wang & Mu, 2017), which specified the phases and tasks of TGP, seemed to be well designed. Therefore, even though the timing within each phase and task was not adequately set, resulting in some students not having enough time for tasks, the sequences of phases and tasks eventually guided students to create their web pages. The successful sequences of various phases could be one reason that interview participants indicated the TGP was well organized and that the collaboration guides were useful.

Regarding the group element of CSCL script (see Dillenbourg, 2002), group formation in Classes B and C, which allowed students to choose their groups, worked very efficiently. However, some participants in Class A and one student in Class C showed low engagement in general, which prevented the other elements of collaboration guides such as phase, task, mode, and timing from taking effect. This low engagement possibly resulted from the grouping method because grouping could influence students' engagement (Borges et al., 2018; Jung & Suzuki, 2015). As a result of the low engagement, group collaboration did not work well with these participants. I had the impression that this disengagement could have occurred because they knew each other well within their groups, and their disengagement was allowed because of their affinity with one another. Therefore, systematic grouping (Borges et al., 2018) could possibly have prevented some student negligence in the TGP activities via possible peer pressure imposed by individual group members.

Regarding the mode of collaboration, which refers to types of collaborative interaction (Dillenbourg, 2002), within-group collaboration and between-group collaboration worked generally well except for some students in Class A and a student in Class C. However, group interviews with participants from Classes B and C revealed a problem in collaboration guidance. Regarding between-group collaboration, students were supposed to give at least twenty constructive feedback comments on other groups' work through the Google Docs comment feature. To meet the feedback requirements, some students provided merely complimentary feedback comments rather than constructive ones. Even though much of the feedback was constructive, and participants in general found the feedback activities useful, the findings indicated that the mode of collaboration regarding feedback activities needed improvement. As a result, I suggest preparing a feedback section on a Google Docs worksheet in which individual students provide each person's feedback on each group's work rather than using the Google Docs comment feature and mandating the amount of feedback.

The timing element of the collaborative activity also needed improvement. Collaboration guides in the form of CSCL scripts have regulations regarding activity duration and deadline (Dillenbourg, 2002). Although the timing of most activities in Classes B and C worked well, the timing needed improvement, specifically regarding presentation time, because the final group activity was a presentation about the culminating product of the entire TGP. I limited the presentation time to 7 minutes, which was too short for most groups of students. As a result, some student groups had to hurriedly present their work because of the time restriction. Because the presentation was a great opportunity to learn from each other's final work, it would have benefitted the students if they had had more time to review other student groups' work through the presentation.

The timing element of collaboration guides (Dillenbourg, 2002) in Class A revealed the restrictions of research studies conducted in natural learning environments (see Collins, Joseph, & Bielaczyc, 2004). It was difficult to predict participants' behaviors and address unexpected behaviors by changing design decisions (Collins et al., 2004). As a result, the timing element in Class A presented more severe problems because there was not enough time for each phase of activities. Although the class duration was 50 minutes, only about 40 minutes were usable for the TGP. In addition, some students came late and only engaged in the activity for about 30 minutes. When I realized this issue and wanted to extend the TGP duration in Class A, it was not possible because other projects and activities were already scheduled. Therefore, the Tech force/Model lesson activities were significantly compromised, and collaborative knowledge building activities could not be finished during the class hours. I felt that two more class hours were needed to implement the originally planned activity without compromise. The timing issue I experienced in Class A led to design challenges in natural settings.

Role of the question prompts. Question prompts were also offered to students to support their collaborative learning regarding digital literacy practices. Question prompts were created and provided as "conceptual scaffolding" to guide students about what to consider when they co-construct their knowledge of digital literacy practices (Hannafin et al., 1999, p.117). Group interviews and participants' responses to the open question on the post-survey indicated that participants in general thought the question prompts were useful for their collaborative knowledge building. These findings validated the role of question prompts, as a micro script, in guiding learners with specified directions (Ge & Land, 2004; Wang & Mu, 2017).

Role of the digital literacy resources. Digital literacy resources were provided in conjunction with question prompts. Resources in general are often offered to support learning (Hill & Hannafin, 2001). The digital literacy resources in this study were prepared to help students conduct research and build collective knowledge regarding their group's digital literacy practice(s). The results and findings from the post-survey and group interviews indicated that participants found the digital literacy resources useful for their collaborative knowledge building. These results and findings validated the assertion that students in collaborative learning benefit from structuralized resources (see Jeong & Hmelo-Silver, 2016).

Role of the popular-culture resources. In addition to collaboration guides, question prompts, and digital literacy resources, popular-culture resources were provided to support students' collaborative knowledge building. Popular culture in classrooms can obtain learners' attention, make what they learn relatable, and build common ground for learning activities (Alvermann, 2012; Lawrence et al., 2009; Pryor, 2008). The results from the post-survey and findings from group interviews indicated that popular-culture resources succeeded in gaining the attention of interview participants and making the learning about digital literacy practices relatable to them. Popular culture particularly played the role of making digital literacy practices relatable through individual knowledge building activities.

In addition, even though it was not required or encouraged, six groups among twelve groups in total from Classes B and C embedded into their final webpage products popular-culture content that had been introduced to them. These results and findings validated the claim that popular culture can be meaningful resources for learning activities (Lawrence et al., 2009; Pryor, 2008), just as interview participants' references to the "Nosedive" episode of the drama *Black Mirror* indicated. In addition, participants' webpages from Classes B and C, in which popular-culture resources were used, showed the potential of popular-culture resources in building common ground for digital literacy knowledge building activities.

Regarding popular culture resources, the results and findings from Class A showed different aspects from Classes B and C. In the individual knowledge building activities of Class A, students demonstrated that popular culture resources could help in making connections between domain knowledge and their actual lives, as shown in the cases of participants from Classes B and C. However, none of the groups incorporated what they learned from popular-culture resources into their final products. As mentioned earlier, this may have been caused by the other instructor's unfamiliarity with the popular culture resources in the TGP. He had not seen most of the popular-culture resources presented in the course. Therefore, he could not share his perspectives about the resources as I did and could not talk about them with his students.

As a result, the popular-culture resources did not have as much of an effect in Class A as in Classes B and C with regard to supporting their collaboration in his students' collaborative work. These findings reveal that as the definition of popular culture—what a group of people experience in common in their everyday lives (Alvermann, 2012)—indicates, if both instructors and learners have shared familiarity with the same movies and pop songs, these movies and pop songs can play a supporting role for learners' collaborative learning to the maximum. Therefore, it seems necessary to choose popular-culture resources that are familiar to both instructors and students or provide both instructors and students with opportunities to experience the popular-culture resources when they are not familiar with them.

In summary, the results and findings in this study indicated that a CSCL environment can be a legitimate learning environment for students' digital literacy development in technology integration courses. In addition, instructional scaffolds such as collaboration guides, question prompts, digital literacy resources, and popular-culture resources can be legitimate contributing factors for facilitating collaborative interaction or digital literacy development in CSCL.

RQ 2. What Digital Literacies are Reflected in the Technology Genius Project Developed in Technology Integration Courses?

In this section, I first interpret the findings mainly from participant products and interviews, and then I discuss my interpretation of the relatively low scores of participants from Class A on pre- and post-surveys compared to those from Classes B and C.

Validation of social constructivist view of digital literacies. The TGP was designed following the social constructivist view of digital literacies (Reynolds, 2016). The participants' digital literacy practices during the TGP and the culminating products, such as each class's Web site and each group's webpage, video commercial, and lesson plan, validated the social constructivist view of digital literacies (see Reynolds, 2016). The social constructivist view of digital literacies was emphasized in the definition of digital literacies in this study—*mastery of media and technology tools and digital literacy practices according to social contexts*—by adding *social contexts* to Reynolds' (2016) definition of digital literacies. Following the definition of digital literacies of this study, the TGP was embedded in the social context (see Gee, 2015; Street, 2008) in which students communicated their digital literacy knowledge with other educators as active agents of digital literacy practices (see Reynolds, 2016). Therefore, the students' final products, such as their designed and published webpages, video commercials, and lesson plans indicated that participants engaged in social interaction rather than learning isolated technologies without social contexts.

The purpose of the TGP was to solve problems proposed in the literature: researchers pointed out that many educators such as K-12 teachers in the United States do not possess the digital literacies needed for using technologies meaningfully to help their students' digital literacy development (Kimmons et al., 2015; Krumsvik, 2014; Tondeur et al., 2017; Wang et al., 2014; Wastiau et al, 2013). To serve its purpose, the designed TGP was implemented to help students in a technology integration course learn digital literacies. Regarding facilitating the digital literacy learning of students in the technology integration course, the TGP design, results, and findings of the current study indicated that identifying digital literacy practice domains (DLPDs), which was recommended by Reynolds (2016), contributed to creating the subject portion of the TGP as well as setting its goal.

In addition to identifying DLPDs, the TGP design and participant products such as webpages, video commercials, and Google Docs worksheets revealed the importance of communication shown in the definition of media and technology (see Reeves, 1998). Students in the TGP interacted with each other, designed, created, and published digital content, established digital citizenship, conducted research, and designed webpages to communicate their collective knowledge with the support of multimodal media and technology with other educators around the world. The webpages and video commercials have been communicating the students' messages in the form of texts, hyperlinks, images, and videos until present (May 2019) since they were published (May 2018). This goal of communicating students' digital knowledge with K-12 educators around the world provided a learning environment in which students played the role active producers rather than consumers (see Jenkins, Ito, & boyd, 2015) by designing and publishing webpages, video commercials, and lesson plans.

Digital literacy development by partaking in digital literacy practices. Designed webpages, video commercials, and lesson plans also validated the assertion shown in the *learning by design* approach, which emphasizes learning technologies in collaborative design processes of solving problems rather than teaching specific tools popular at certain times (Koehler & Mishra, 2005). However, in contrast to the *learning by design* approach and adopting the TPACK framework that focuses on designing artifacts such as lesson plans and course units (see Iskeceli-Tunc & Oner, 2016; Koehler & Mishra, 2005; Mishra & Koehler, 2006; Agyei & Voogt , 2012), the TGP facilitated students' learning of digital literacies by helping the students join a participatory culture (see Jenkins et al., 2015; Lotherington & Jenson, 2011) and engage in six digital literacy practices: interacting with other people, creating, publishing, establishing digital citizenship, conducting research, and solving problems. Despite the differences in focus between the two approaches, the results and findings of the TGP indicated that students in technology integration courses can learn digital literacies from engaging in active knowledge construction and authentic practices rather than learning digital literacy knowledge passively and practice using specific tools.

Regarding students' digital literacy learning in technology integration courses, this study suggested that students in technology integration courses can benefit from learning digital literacy knowledge and skills and having positive attitudes toward digital literacies according to Ferrari's (2012). In addition, students in technology integration courses also need to have pedagogical knowledge of technology integration (Instefjord & Munthe, 2016; Mishra and Koehler, 2006; Tondeur et al., 2017). Although these tasks of improving students' digital literacy knowledge, skills, and attitudes as well as pedagogical knowledge of technology integration in technology integration courses appear complex, the results and findings of this study indicate that focusing on meaningful digital literacy practices can help students improve their digital literacies.

Digital literacy knowledge development. The group interviews and participant products from all the classes indicated participants improved their knowledge of six digital literacy practices by participating in digital literacy practice of co-constructing knowledge. In a modern education context in which information is abundant (Alvermann, 2012), participants in this study engaged in conducting research on digital literacy practices; constructing knowledge together; and communicating their knowledge with other people through multimedia and webpages. As a result, participants' improved digital literacy knowledge showed TGP's potential as a useful way to improve students' digital literacy knowledge.

Digital literacy skill development. In addition to the growth in digital literacy knowledge, participant products and group interviews indicated participants' improved skills in implementing digital literacy practices. According to Reynolds' (2016) recommendation that suggested identifying digital literacy practice domains and focusing on digital literacy practices rather than on specific skills popular in specific times, the TGP concentrated on students' implementing identified digital literacy practices rather than teaching how to use specific tools. As a result, through the TGP, participants joined a participatory culture (Jenkins et al., 2015; Lotherington & Jenson, 2011; Meyers et al., 2013) of publishing webpages, video commercials, and lesson plans to share their collective knowledge with educators around the world. Students in the TGP demonstrated their skills in designing webpages; interacting with classmates; designing, creating, and publishing video commercials; establishing digital citizenship; and conducting research. The findings indicated that students in technology integration courses can develop their digital literacy skills in technology integration courses that help students engage in digital literacy practices rather than teaching specific tools.

Digital literacy knowledge development regarding technology integration. As mentioned earlier, students in technology integration courses can also benefit from learning how to use technologies in K-12 schools (Instefjord & Munthe; 2016; Tondeur et al., 2017). It is often said that current students in technology integration courses are digital natives who are used to using digital tools (Ng, 2012; Prensky, 2001). However, I observed that they were mostly unfamiliar with using technologies for education. Just as researchers indicated (Johnson, 2012; Ng, 2012; Sun et al., 2017), the students needed much help with using technology meaningfully for education. Reading Howland et al. (2012) and responding to questions related to *learning* *with technology* or discussing the topic was not enough for participants in this study to create lesson plans in which technologies were meaningfully integrated.

As a result, in this study, there were lesson plans that were not meaningful enough considering the five elements of meaningful learning (see Howland et al., 2012), although participants certainly demonstrated their collective knowledge regarding how to use technology for education. That is to say, some participant groups indicated that they did not have enough pedagogical knowledge to use technology meaningfully for education in K-12 schools. These findings indicate the necessity of modifying the TGP design so that it can help students more effectively build pedagogical knowledge of meaningful integration of technology.

Digital literacy attitudes development. In addition to digital literacy knowledge and skills as well as knowledge of technology integration into education, attitudes toward digital literacies are also considered to be a part of digital competence (Ferrari, 2012) and have been the research topic of many researchers (see Cervetti et al., 2006; Kist & Pytash, 2015; Lotherington & Jenson, 2011). Recognizing the importance of students' attitudes toward digital literacies, the TGP was designed to help students have positive attitudes toward digital literacies through their participation in the tasks with the authentic elements in which students can realize the ease, enjoyment, and usefulness of using technology (see Davis, 1985). The participants' enjoyment in the TGP and the general growth in participants' positive attitudes toward digital literacy education indicated in the results and findings suggest that the TGP can contribute to helping students have positive attitudes toward digital literacies.

Furthermore, regarding participants' attitudes regarding digital literacy education, most participants displayed positive attitudes toward digital literacy education in K-12 schools in a discussion during the TGP through the interactive response system, Mentimeter. The positive attitudes of participants contrasted with the attitudes of many teachers (Hutchison & Reinking, 2011; Kist & Pytash, 2015) and even some fellow students in technology integration courses (Kist & Pytash, 2015) who were reluctant to incorporate digital tools to help engage in digital literacy practices such as publishing digital content to blogs. The positive attitudes of participants indicated the possibility that they will transform education in K-12 schools with regard to digital literacy education when they become teachers.

Changes needed to the TGP design. However, with regard to digital literacy development and changes in digital literacy attitudes toward K-12 education, the scores of participants from Class A were not as high as those from Classes B and C. These relatively low scores may have resulted from the lack of time for the TGP and from the relatively low engagement of participants in Class A. This indicated that the timing element (see Dillenbourg, 2002) of the collaboration guides did not work as planned because there was not enough time for the TPG in Class A. This shortage of time for the TGP resulted in compromising such TGP activities as Tech force/Model lesson and led some groups to not have enough time for their collaborative knowledge building activities during the class. As a result, this shortage of time may have contributed to participants' less effective digital literacy learning in Class A.

In addition, the observed relatively low engagement of the participants in Class A may provide another reason for the relatively low scores of the participants from that class. Behavioral disengagement such as tardiness, absences, and lack of attention to the TGP activities may have influenced the collaborative learning of the participants. Engagement can be seen as a more active concept than motivation (Kim, Park, Cozart, & Lee, 2015). While motivation is a *desire* to achieve learning outcomes, engagement entails the *ability* to achieve these outcomes

(Kim et al., 2015). This means engagement is more directly linked to students' learning outcomes, and motivation alone cannot explain students' achievement.

Student engagement can be considered the "glue, or mediator, that links important contexts—home, school, peers, and community—to students and, in turn, to outcomes of interest" (Reschly & Christenson, 2012, p.3). This explanation of engagement and the relationship of engagement with learning outcomes partly explains the relatively low achievement of participants from Class A. The restrictions exhibited in Class A such as the shortage of time for the TGP activity suggested a need to modify the current TGP design. Specifically, these restrictions suggested the need for more carefully customized collaboration guides across classes. For example, a stricter attendance policy to ensure student attendance, a different grouping method, and a more adequately pre-designed duration for each activity were all needed for Class A.

Even though some aspects of the TGP need improvement, in general, the results and findings indicated growth in digital literacy knowledge and skills as well as digital literacy knowledge of integrating technology in education. As mentioned in earlier chapters, college programs in technology integration courses can be a starting point for changing literacy practices in K-12 education (Cervetti et al., 2006). Therefore, the results and findings in this study will contribute to this effort (Alvermann et al., 2016; Gee, 2015; New London Group, 1996; Street, 2008) to change school literacy practices. College programs in technology integration courses can benefit from the results and findings in this study, which suggested that students in technology integration courses can build their digital literacy knowledge and skills and reinforce positive attitudes toward digital literacy education in K-12 schools by engaging in the social practice of interacting with each other, creating and publishing digital artifacts, establishing adequate digital citizenship, conducting research, and solving problems.

In the next section, I will present interpretations of the results and findings related to collaboration guides and scaffolds in this study. In addition, I also discuss the modifications needed based on the results and findings of this study.

Implications for Research

I explored a CSCL environment supported by the multiple scaffolds for students' digital literacy improvement in technology integration courses. The conceptual framework of digital literacies was based on socio-constructivists' view of digital literacy (see Reynolds, 2016). Rather than teaching how to use specific tools, this study put emphasis on students' digital literacy practices.

To serve the purpose of helping students engage in authentic digital literacy practices, this study, first, identified digital literacy practice domains for undergraduate students in technology integration courses based on the Reynolds' (2016) suggestion. Next, this study suggested that students in technology integration courses can benefit from improving their digital literacy knowledge and skills (Ferrari, 2013) as well as pedagogical knowledge of technology integration (Howland et al., 2012). Third, this study proposed that multiple scaffolds can facilitate students' digital literacy development in CSCL environments by supporting students' collaborative interaction and knowledge construction. Finally, this study distributed the multiple scaffolds such as collaboration guides (Wang & Mu, 2017), question prompts (Ge & Land, 2004), resources (Hill & Hannafin, 2001), and popular culture resources (Alvermann, 2012) across the TGP because collaboration guides can help students achieve their goals by coordinating collaborative interaction and the other scaffolds can help students improve their understanding of digital literacy practices.

The results and findings indicated that CSCL environments can be a legitimate learning environment for digital literacy development for students in technology integration courses when collaboration guides adequately specify the script elements such as phases, group formation method, tasks, mode, and timing (see Dillenbourg, 2002). In addition, this study indicated that collaboration guides, question prompts, and digital literacy resources can facilitate students' digital literacy development in technology integration courses by facilitating their collaborative learning. Popular culture also became relatable resources for students' digital literacy development and showed the potential for mediating collaborative learning with regard to digital literacy education in technology integration courses. However, further research is needed to validate CSCL environments with multiple scaffolds for digital literacy development in technology integration courses. Below are my suggestions.

Validation of Digital Literacy Practice Domains for Students in Technology Integration Courses

In this study, I proposed six digital literacy practice domains based on the contemporary learning practice framework (Reynolds, 2016), ISTE standards for students (ISTE, 2016) and teachers (ISTE, 2017), and DIGCOMP (Ferrari, 2013). The identified DLPDs can be validated, modified, and expanded according to diverse and ever-changing digital literacy practices for students in technology integration courses. Reynolds (2016) also pointed out the importance of recognizing dynamic changes in technological advancement and identifying digital literacy practice domains corresponding to specific subject or practice areas. Therefore, the validation and identification of digital literacy practice domains will help other researchers define digital literacies and measure digital literacy developments and help educators implement digital literacy education in their subject areas with clear ideas of what to teach.

Measurement of Digital Literacies for Students in Technology Integration Courses

The participants in the study reported their perceptions regarding digital literacy knowledge and skills as well as their pedagogical knowledge of digital literacies by responding to the survey questions. In the same way, they reported their attitudes toward digital literacy education in K-12 schools. However, there are limitations in self-report methods for measuring constructs (Dunning et al., 2004). Therefore, the quantitative data did not tell what really happened during the TGP although they showed the differences in participants' scores between pre- and post-surveys. In addition, as mentioned in earlier chapters, focusing on using specific technology tools relevant only in specific places at specific times is also not adequate considering the drastic nature of technological advancement (Reynolds, 2016). Therefore, this necessitates research studies focusing on how to measure students' digital literacy development from the perspective of digital literacy practices rather than from the frequency of using specific tools in technology integration courses. The quantitative methods of measuring students' digital literacies will provide qualitative researchers with an alternative way to explore students' digital literacies. These quantitative studies regarding digital literacies will also be beneficial for researchers and educators who try to investigate the effects of digital literacy programs or projects.

Further Research regarding the Legitimacy of CSCL Environments for Digital Literacy Development

This study investigated students' digital literacy development in technology integration courses in a CSCL environment. Web 2.0 tools have changed how we use technology by realizing the creative, communicative, collaborative, and participatory aspects of technologies (Alvermann, 2012). However, there is a lack of research regarding learning environments designed to improve learners' capabilities for interacting with each other, creating and publishing digital artifacts, establishing adequate digital citizenship, conducting research, and solving problems in authentic social contexts of digital literacy practices. Even though this study indicated the possibility of a CSCL environment as a legitimate environment for digital literacy development, further research studies will benefit researchers and educators who are looking for ways to implement digital literacy education for students in technology integration courses.

Further Research regarding Scaffolds for Digital Literacy Development

The results and findings in this study indicated that students in technology integration courses, who are often called digital natives (Ng, 2012; Prensky, 2001), do not have much difficulty in using new technology. However, this study also revealed that they needed help with learning how to use technologies meaningfully for education, which is also reflected in other studies (Johnson, 2012; Ng, 2012; Sun et al., 2017). Therefore, students in technology integration courses can benefit from studies which provide scaffolds to help students improve their knowledge of and skills in integrating technology meaningfully into education and for using technology in digital literacy practices. This study indicated that the multiple scaffolds can support students' digital literacy development in technology integration courses in a CSCL environment. However, some of the participants' lesson plans indicated that students needed more improvement regarding integrating technology meaningfully into education (see Howland et al., 2012) Therefore, further research studies focusing on scaffolds in CSCL environments that support students' digital literacy development from the perspective of meaningful integration of technology in education will help researchers and educators in designing and organizing activities needed for technology integration courses.

The Role of Popular Culture Resources in Digital Literacy Courses

This study provided popular-culture resources to facilitate students' learning of digital literacy practices in technology integration courses. As a result, popular-culture resources showed potential as a scaffold to play a facilitating role in students' collaborative learning in Classes B and C. However, popular culture has not gained enough attention in the field of digital literacy education. Cultures are often disregarded in the field of instructional design (Asino, 2015). The popular-culture resources shared by students in technology integration courses, such as movies, TV dramas, and pop songs, can be an effective scaffold for improving digital literacy knowledge. Therefore, further research regarding the role of popular culture in learning digital literacy can benefit students in technology integration courses in terms of digital literacy improvement by offering them relatable resources, just as the *Black Mirror* "Nosedive" episode was able to in the current study.

Implications for Practice

The results and findings suggest the practicality of identifying digital literacy practice domains for students in technology integration courses and facilitating their collaborative work in CSCL environments with the support of collaboration guides, digital literacy resources, question prompts, and popular-culture resources. This study contributes to digital literacy education for students in technology integration courses, shares its insights into improving digital literacies for educators in general, and has implications for educators who want to design CSCL environments in which students co-construct knowledge and build collaborative products with the support of necessary scaffolds. Below are suggestions for practice emerging from this study.

Instructors and digital literacy programs can facilitate students' digital literacy development by designing a project in which students are expected to engage in identified digital literacy practices by partaking in authentic tasks. For example, students in this study engaged in digital literacy practices—communicating and collaborating with each other; designing, creating, and publishing digital artifacts; establishing digital citizenship; and conducting research—by participating in publishing webpages to share digital literacy knowledge with educators around the world. Likewise, students in other digital literacy programs or technology integration courses can improve their digital literacy knowledge and skills by implementing digital literacy practices through authentic tasks. Table 6-1 presents the principles and suggestions for implementing digital literacy education in general as well as technology integration courses.

Table 6-1

Summary of the Implications for Practice in Digital Literacy Education

Areas	**Principles**	**Suggestion for the Implementation**
Knowledge	Identify digital literacy practice domains rather than focusing on finding popular tools (Reynolds, 2016).	• The identification needs to be based on what the literature says as well as what participants mainly do in their natural practices • Gather knowledge of the digital literacy practices identified • Based on the digital literacy practice domains identified, allow students to construct their own knowledge regarding the identified digital literacy practices with the support of resources and instructors
Skills	Rather than teaching specific skills popular at the time, focus on helping students participate meaningfully in digital literacy practices (Reynolds, 2016).	• Design activities or projects in which learners can participate in digital literacy practices so that they can acquire the skills necessary for the practices and identify the skills for partaking in the practices • Design activities and projects in which students communicate, collaborate, and research using media and technologies in the process of joining participatory cultures • Challenge learners to solve problems they face for themselves during activities and projects

Helping K-12 students	Improve the understanding of integrating technologies meaningfully into education (Howland et al., 2012)	• Design model activities and projects which demonstrate meaningful integration of technology • Give learners opportunities to co-construct lesson plans so that they learn from each other's ideas • Provide feedback on learners' lesson plans with regard to their meaningfulness • Give learners enough time to modify and update their lesson plans to make sure that they are meaningful enough
Attitude	Design authentic learning activities in which learners can realize the usefulness and ease of using technology (Davis, 1985)	• Allow students to choose their own tools for performing digital literacy practices in authentic contexts • Provide students with the opportunity to learn from other students regarding diverse tools and their usefulness
Learning Environments	Design communicative and collaborative learning environments in which the communicative nature of media and technologies can be realized	• Allow students to communicate and collaborate with media and technology so that they can learn the practice of communication and collaboration • Have students learn from each other through collaboration
Scaffolds	Support learners' interactions and digital literacy development with scaffolds	• Guide students' communication and collaboration so that social interactions take place actively • Provide question prompts in order to problematize digital literacy practices and guide learners' research regarding digital literacy practices and related tools • Offer resources for students' learning so that they can build a base for conducting further research on digital literacy practices and related tools
Popular culture resources	Maintain learners' attention and make what they learn relatable through popular-culture resources (Alvermann, 2012; Lawrence et al., 2009; Pryor, 2008).	• Choose popular-culture resources that are familiar to both instructors and students • Have opportunities to watch or view the popular-culture resources together • Have learners reflect on popular-culture resources so that they can give attention to digital literacy practices • Offer learners common ground for working together through popular culture

As shown in Table 6-1, digital literacy programs can benefit students by identifying digital literacy practice domains (Reynolds, 2016); designing programs focusing on digital literacy practices rather than specific skills (Reynolds, 2016); helping learners communicate, collaborate and participate in sharing information using media and technology (Wang & Mu, 2017); supporting learners' collaborative interaction with scaffolds (Kirschner & Erkens, 2013; Wang & Mu, 2017); and integrating relatable popular-culture resources (Alvermann, 2012). Even though digital literacy programs are complicated because of difficulties in defining digital literacies for educators and designing adequate learning environments, the suggestions made in this study can offer streamlined guidelines for digital literacy programs for educators.

Limitations

This study had several limitations. First, I was conducting this research in courses (Classes B and C) I taught as the instructor of the research participants, although students in the course (Class A) taught by another instructor were invited to this study. Even though I explained to students from my courses that I needed their honest feedback about the course, some research participants might not have wanted to hurt my feelings by giving negative feedback. To reduce the limitation of conducting this research in the course I taught, I triangulated data sources from surveys, participant products, and my observations.

Second, there were limitations in my observations. I observed Class A as a non-participant observer and Classes B and C as a participant observer. The observations were essential and useful for investigating what was happening in the classes. However, it was difficult to explore the aspects of participants' collaborative and cooperative work in the classes because I had to concentrate on my teaching in Classes B and C. In addition, capturing what students were talking in Class A was difficult because I might interfere with their activities by standing beside their groups' tables and watching what they were doing. Therefore, even though the observations gave me general understanding about class activities, I had limited understanding about how collaboration and cooperation worked within each group. To overcome the limitations in my observations regarding the aspects of each group's collaboration and cooperation, I asked interview participants how they worked together to achieve their goals.

Third, this study only investigated a unit within a course. Therefore, this study did not show how entire digital literacy courses could be constructed in a CSCL environment with the support of collaboration guides and multiple scaffolds.

Fourth, regarding the pre- and post-surveys, there were the limitations of self-assessments (Dunning, Heath & Suls, 2004). People often overrate and commit errors when assessing their own knowledge and skills (Dunning et al., 2004). Therefore, there were possibilities that participants' perceptions regarding the level of their digital literacy knowledge and skills did not correspond to their performance levels in reality.

Finally, this study had limitations in generalizability. This study had a small sample size and was conducted in a naturalistic environment to improve digital literacy courses in CSCL. The findings of this study may have limited application to other learning environments. The next chapter presents results and findings from the data analysis described in this chapter.

Final Insights

This study contributes to digital literacy education for students in technology integration courses. My experiences with a technology integration course and discussions with my fellow instructors indicated that instructors for students in TICTP often have difficulty in identifying what to teach and how to create learning environments to facilitate students' learning of digital literacies. The literature also indicated that many teachers can benefit from learning how to integrate media and technology meaningfully into education (Kimmons et al., 2015; Krumsvik, 2014; Tondeur et al., 2017; Wang et al., 2014; Wastiau et al, 2013). Because many students in technology integration courses will implement digital literacy practices when they become educators, college education programs should provide adequate subject content and meaningful learning activities for students in technology integration courses (Røkenes & Krumsvik, 2014; Tondeur et al., 2018).

Therefore, this dissertation study suggests that students' digital literacy development in TICTP can be facilitated by focusing on digital literacy practices in communicative and collaborative learning environments. These findings indicate that instructors for students in technology integration courses can begin with identifying digital literacy practices necessary for students in technology integration courses following Reynolds's (2016) suggestion. It is possible to mislead students if the course focuses on teaching specific tools popular at certain times because tools often disappear (Koehler & Mishra, 2005; Reynolds, 2016). Therefore, students in technology integration courses can benefit from participating in authentic and participatory digital literacy practices through Web 2.0 technology rather than learning specific tools.

Once the digital literacy practices for students in technology integration courses are identified, adequate learning environments for students' digital literacy practices need to be considered to facilitate students' digital literacy development. This dissertation proposed a CSCL environment to support students' communication, collaboration, creation, publishing, digital citizenship establishment, research, and problem-solving practices. This study suggests that a CSCL environment with collaboration guides and resources (Kobbe et al., 2007) can support students' digital literacy practices by helping them join communicative, collaborative, and participatory design projects.

More specifically, students' digital literacies in technology integration courses can be guided by collaboration guides, question prompts, digital literacy resources, and popular-cultural resources. Collaboration guides can guide students' communication, collaboration, creation, publishing, digital citizenship establishment, and problem solving while they are completing the final product. In association with collaboration guides, other scaffolds—question prompts, digital literacy resources, and popular-culture resources—facilitate students' collaborative knowledge building regarding digital literacy practices.

This dissertation reported the results and findings regarding students' digital literacy development in a CSCL environment supported by multiple scaffolds: collaboration guides in the form of CSCL scaffolds, question prompts, digital literacy resources, and popular-culture resources. Based on the suggestions of Reynolds (2016), digital literacy practice domains for students in technology integration courses were identified based on the digital literacy frameworks and standards such as social interaction, creation, publishing, digital citizenship, research, and problem solving. The TGP was designed to support students' digital literacy practices in a collaborative learning environment with multiple scaffolds mentioned above.

The results and findings from this study indicate the legitimacy of identifying digital literacy practice domains and focusing on students' performing digital literacy practices rather than on learning specific tools. In addition, the results and findings revealed that CSCL environments with multiple scaffolds can support students' digital literacy development and digital literacy practices adequately. The interventions, results, and findings in this research as well as further research studies related to this research will contribute to students' digital literacy development in technology integration courses.

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APPENDICES

Appendix A

Pilot Study

A pilot study during Fall 2017 was conducted in order to establish design guidelines for digital literacy courses for students in technology integration courses as well as to obtain initial ideas about what students' experiences are in the course activities. The data collection processes for the pilot study was as follows.

Pilot Study Data Collection Process

Participants were students enrolled in a technology integration course that I taught. The context for the pilot study was to develop a new digital literacy course in an introductory technology integration course for students in technology integration courses. 20 students took the course. I distributed an invitation letter in the classroom and gave a consent form. Initially, only five students agreed to participate in the research. To recruit more students, I sent a follow-up email to the students to encourage them to participate in the research. After the follow-up email, six more students agreed to participate in the study; eleven participants in total agreed to participate in my study. However, a student was excluded from the study because he was under the eighteen. The duration of the pilot study was from September to November. The participants were asked to complete the pre-survey at the beginning of the study and the post-survey at the end of study. The research participants engaged in diverse course activities designed to develop their digital literacies.

I sent an interview invitation letter to research participants to recruit interview participants. The purpose of the interview was to refine digital literacy course design by understanding participants' experiences with the course. I interviewed three students, and each interview was about 30 minutes long.

Pilot Study Data Analysis

The pilot study adopted a mixed methods design. Both quantitative and qualitative data, such as the surveys, interviews, observation, course activity products, and archival data, were collected. Table A-1 shows five different data that I collected to investigate the research questions. The surveys in the pilot study were analyzed through the Wilcoxon signed-rank test. The qualitative data, such as interviews, research participants' class products, and observation notes, were analyzed to find patterns and themes. I briefly summarized the patterns and themes found in the data analysis in this prospectus. In the next section, I describe the results from the pilot study.

Table A-1

Pilot Study Data Collection Methods

Data	Content
Pre- and post-surveys (Appendix B & C)	Questionnaire regarding digital literacies, collaboration, and popular culture
Interview protocol (Appendix D)	Interviews regarding research participants' class experiences
Observation	Instructor's reflections and observation notes about classes
Course activity products	Products of collective knowledge construction, individual activities, and class project artifacts
Archival data	Course content such as popular cultural materials and other teaching and learning materials

Pilot Study Results

I analyzed the data to explore the research questions specified earlier. I describe the results in the following sections.

Research Question 1. First, I investigated the following research question mainly based through survey, interviews, and students' products: How does students' digital literacy in technology integration courses develop during the course? The following is the description of results based mainly on surveys and interviews

Survey. Because of the small sample size, I conducted nonparametric Wilcoxon Signed-Rank test to compare mean differences between pre- and post-surveys on research participants' digital literacy development (Russell, 2018). I specifically analyzed five digital literacy domains and participants' digital literacy competency in helping their future students. As A-2 indicates, there were statistically significant increases in the variables such as helping others in social interaction ($Z = -2.113$, $p = 0.035$, $r = -0.52$), creating ($Z = -2.524$, $p = 0.012$, $r = -0.63$), helping others create digital artifacts ($Z = -2.524$, $p = 0.012$, $r = -0.63$), publishing ($Z = -2.383$, $p = 0.017$, $r = -0.59$), helping others publish digital artefacts ($Z = -2.380$, $p = 0.017$, $r = -0.59$), establishing digital citizenship ($Z = -2.313$, $p = 0.021$, $r = -0.57$), and helping others establish digital citizenship ($Z = -2.342$, $p = 0.019$, $r = -0.58$).

Table A-2

Digital Literacy Analysis Result

	Pre-survey (n = 8)		Post-survey (n = 8)		*Result of Wilcoxon Signed-Rank test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Social interaction	7.958	0.880	8.9167	0.660	–1.787	.074	–.44
Social interaction: helping	7.416	1.094	8.7917	0.688	–2.113	**.035**	–.52
Creating	4.500	1.259	8.1250	1.006	–2.524	**.012**	–.63
Creating: helping	3.916	1.455	7.8333	1.168	–2.524	**.012**	–.63
Publishing	4.666	2.182	8.2083	0.775	–2.383	**.017**	–.59
Publishing: helping	4.208	2.370	8.0000	1.023	–2.380	**.017**	–.59
Digital citizen	7.583	0.556	8.7083	0.744	–2.313	**.021**	–.57
Digital citizen: helping	7.166	0.872	8.4583	8.458	–2.342	**.019**	–.58
Problem solving	8.458	1.207	9.0833	0.791	–1.382	.167	–.34
Problem solving: helping	8.500	1.259	9.0000	0.908	–1.490	.136	–.37

Note. Significant positive effects are in bold.
Scores can range from 1 to 10

Students' products and Interview. The interview participants were three students who took my technology integration course. One theme emerged from the analysis of the interviews and documents such as students' activities and products regarding digital literacy development in the course: *students engaged positively in communicating, collaborating, creating, solving problems, and establishing digital citizenship*. Figure A-1 shows activities in the course and research participants' products created during class or submitted as assignments. The products display the results of research participants' digital literacy development as well as their digital literacies related with digital literacy practice domains.

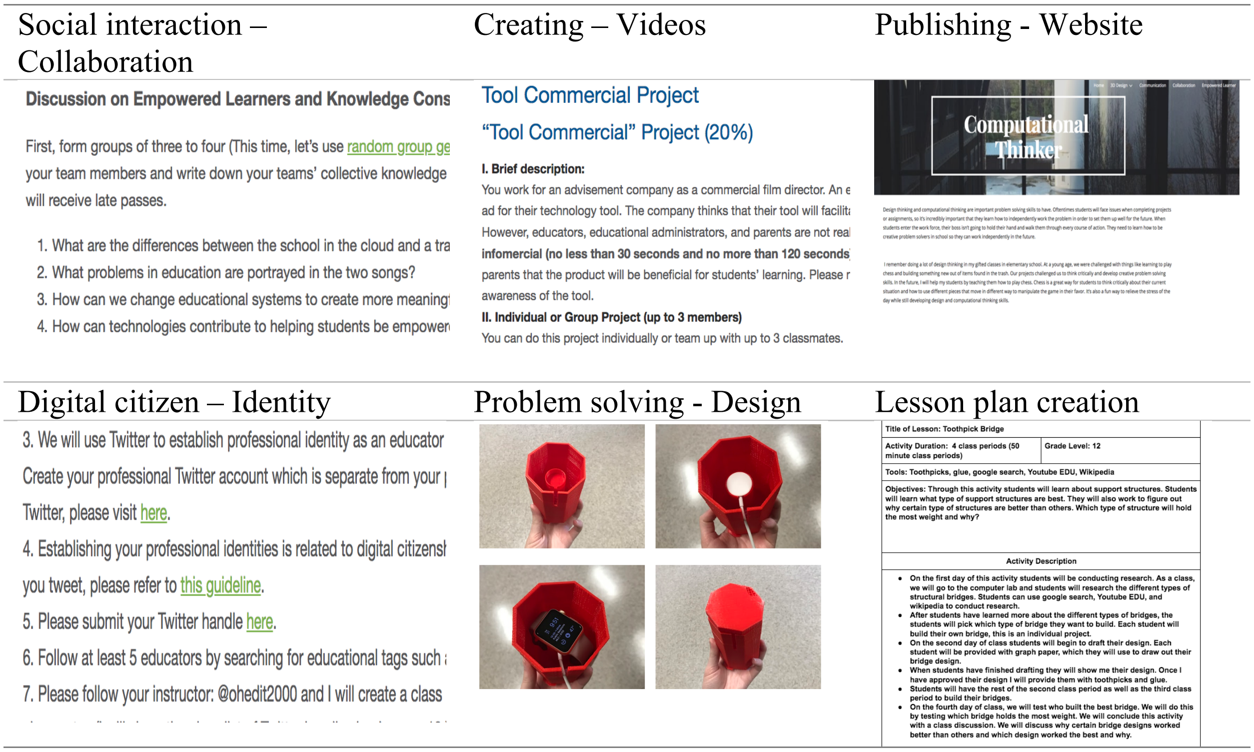


Figure A-1. The digital literacy activities and students' products.

The interview results, shown below, indicated that students thought the course was engaging and that they valued the learning experiences.

- I have just learned so much. I've enjoyed so much and seeing how you can use these technologies in the classroom and like, it excites me to use them. I can just imagine how my students are gonna love it and I kind, I just wish that I had I had used these when I was in high school in middle school.
- I really enjoyed being able to play, and I really enjoyed the fact that it was all on the computer. So, it was easy to work with the computer and not having to write down and overall the experience is really good. You taught very well.

The results of surveys, interviews, and students' products indicated that students developed their digital literacy in an engaging manner.

Research Question 2. I explored the following research question by analyzing survey, interviews, and observation data: What are the students' experiences with collaborative activities? The following are the results.

Survey. To analyze students' experiences, I specifically analyzed collaboration perceptions on the variables such as learning, process satisfaction, product satisfaction, and technology usage in collaboration. I employed the Wilcoxon Signed-Rank test to explore mean difference between pre-survey and post-survey (Russell, 2018). I chose the non-parametric Wilcoxon signed-rank test because of the small sample size (Russell, 2018). As Table A-3 shows, the results were not statistically significant, and the participants' perceptions about collaboration products decreased (Z = 2.263, p = 0.024, r = 0.56). This suggests that participants were less satisfied with the products that they had worked on together than they had initially expected. This lack of satisfaction indicates that collaboration supports, such as guides, resources, management, and assessment methods, were not effective in the pilot study. Therefore, in my proposed study, it is necessary to organize and support students' collaborative activities so that they produce products resulting in satisfactory ratings. Changes in the current study are described later in this chapter.

Table A-3

Collaboration Perception Analysis Result

	Pre-survey (n = 8)		Post-survey (n = 8)		*Result of Wilcoxon Signed-Rank Test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Interaction/learning	3.982	0.514	4.035	1.277	–1.185	.236	–.296
Process satisfaction	3.700	0.282	3.600	0.868	.344	.731	.086
Product satisfaction	4.083	0.218	3.604	0.518	2.263	**.024**	.565
Technology usage	4.541	0.501	4.250	1.388	.378	.705	.094

Note. Significant effects are in bold.
Scores can range from 1 to 5.

Observations and Interviews. With regard to collective knowledge building activities shown in Table A-4, one theme emerged from the analysis of observation and interviews: *Students often cooperated with each other rather than put collaborative efforts into constructing* *knowledge together*. In the pilot study, collaboration guides were not offered for collective knowledge building (CKB) activities because the CKB activities looked simple, and I predicted that collaboration would occur without collaboration guides. However, I observed that students mainly cooperated to complete the task, which seems to suggest that they placed a higher value on efficiency of task completion than on the benefits of co-constructing knowledge.

Table A-4

CKB Activities in Fall 2017

CKB activities	Collaboration guides	Digital literacy domain
Collaborative writing on communication using technology	No collaboration guides	Social interaction
Collaborative writing on collaboration using technology		Social interaction
Collaborative writing on digital citizenship using technology		Digital citizenship
Collaborative writing on empowered learners using technology		Research
Collaborative writing on design thinking technology		Problem solving

My observation and the following interview results from three students indicate that the design of CKB activities shown in Table A-4 needs to be improved.

- Sometimes it's divided and I think we would learn better with it all of us talk about each question.

- I think when you just have a list of questions, it's very easy just to say okay you do number one, I'll do number two, you do number three and kind of split it that way. Um, so I think maybe if they were like a different platform other than Google Documents, kind of forced a group to work together, that it would be more interactive.
- They were, they would sometime write their own thought and I would just read over it and if there was barely any commenting, but sometimes, so that was the situation. Sometimes we just split us and some people didn't really get to say a lot and yes that was like, that was a problem.

In the interviews above, students were aware that they sometimes assigned each question to each student, and a student suggested that it would be better if a group was forced to work together. This result shows the necessity to support students' collaboration with collaboration guides. Although I did not use collaboration guides in the activities in Table A-4, I incorporated collaboration guides into other collaboration activities shown in Table A-5. The activities were designed to improve students digital literacies in technology integration courses regarding creating, publishing, and problem solving.

Table A-5

Collaborative Activities with Collaboration Guides in Fall 2017

Collaborative activities	Collaboration guides	Digital literacy domain
Creating commercial Film	Collaboration guides were provided	Creating / Publishing
Robotics Challenge		Problem solving
Creating MOOC with popular cultural topics such as football skills, cooking, and movies		Creating / Publishing

Through the collaboration guides, I offered procedures for collaboration and what kinds of role they can play for the activities. As an example of collaboration guide in the pilot study, I included the collaboration guides for a robotics challenge activity in Appendix E. Collaboration guides in these activities worked fine in facilitating collaborative works based on my observation and interview results. In Fall 2017, I asked three students about the collaboration guides for the robotics challenge activity. The following shows the three interviewees' responses about collaboration guides for the robotics challenge.

- It was good that we each had task because while we were still we still were working together we were still collaborating but we each knew what our role was, which I think is really good, but it wasn't like you know, I'm doing this, you do that. We were still collaborating at the same time.

- It was um kind of nice to have the roles already laid out and then we can just you know assign somebody to a certain role so that you know what your job is you know what you're supposed to be doing.
- It gave us each responsibility or what was expected of us. So, we were all required to work on it together as a team.
- The director we basically you assigned them the leadership the leader role and so we counted on them to help us understand what we needed to do and keep us on track on finishing the project. And the controller I think, um, I think we all did that role because we all sometimes help the person who was programming or the two people that were programming moved the robot around. So I don't think it was just one person, but we were all working on it together and then the programmer, we were all kind of working on it together. So, I think everyone did their role…

The students' responses indicate that the collaboration guides, such as the robotics challenge guide, enabled students to work together more effectively. The interviewees stated that collaboration guides supported their collaborative work during the robotics challenge by specifying what roles they should play and which tasks they should complete with the roles. This result shows the positive role of collaboration guides in CSCL.

Research Question 3. I explored the following research question by analyzing survey and interviews: What are the students' experiences with popular culture embedded in the course? The following are the results of the analysis.

Survey. I analyzed participants' attitudes to popular culture on variables such as participants' emotions, relatability, attentiveness, and intention to use for education. I conducted the Wilcoxon Signed-Rank test to compare mean differences between pre- and post-survey on research participants' popular culture attitudes (Russell, 2018). As Table A-6 shows, the results were not statistically significant. However, the average means of both pre-survey and post-survey indicated that the research participants had highly positive attitudes about popular cultures in education. This result suggests that popular culture can be a great resource for technology integration courses.

Table A-6

Popular Culture Perception Analysis Result

	Pre-survey (n = 8)		Post-survey (n = 8)		*Result of Wilcoxon Signed-Rank Test*		
	M	*SD*	*M*	*SD*	*Z*	*p*	*r*
Popular culture and digital literacy	4.13	0.835	4.13	1.126	0.000	1.00	.00
Popular culture and attention	4.13	0.835	4.25	1.289	–0.276	.783	–.06
Positive emotion	4.25	1.035	4.13	1.356	.447	.655	.11
Popular culture for education	4.38	0.744	4.13	1.356	.378	.705	.09

Note. Scores can range from 1 to 5.

Interview. Regarding popular-culture resources, the interview participants' responses were also positive as the following excerpts indicate.

- I think a lot of classes don't use pop culture so it's just like a good way to get your students' attention and to like know that let them know that you are trying to relate to them you know like you want them to be learning these things and you're doing your best to relate to really the content to them
- …it was such a good idea and it really connected everything. It related it to like what we relate to what students relate to and helped us understand you know what you were teaching us also. We should, we talked about *the Imitation Game* a little bit yeah but like seeing that and seeing how you related it, it's like making connections and like understanding what you're saying…

These students' responses show that popular-culture resources made the learning content relatable to students and helped them understand learning content better. In the next section, I describe how the pilot study guided the current study.

APPENDIX B

Pilot Study Pre-survey

Demographic Survey

1. What is your name: ____________________________

2. What is your UGA email address?
____________@uga.edu

3. What is your gender?
________ Female ______ Male _____Other: ________

4. What is your age in years?
________ years

5. What is your race/ethnicity?
________ Asian
________ Black
________ Hispanic
________ White
________ Other: ________________

6. How many semesters have you completed at UGA (Please, do NOT include this semester)?
________ semester (s)

7. How many credit hours have you completed at UGA (Please, do NOT include this semester)?
________ credit hours

8. What is your academic major? (Or What is your academic major that you want to pursue if you have not decided yet?)
____

Digital Literacy Survey

Listed below are 15 important digital literacy skills. For each one, please respond in two ways. First, please rate your own skill level of a ten-point scale from 1=Novice to 10=expert. Second, please rate your level of confidence that you can help others (such as future students if you become a teacher) learn this particular digital literacy skill.

1. **Creating websites using tools such as New Google Sites, Wix, Wordpress, etc.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

2. **Creating digital artifacts such as images, audio, and videos, etc.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

3. **Design and make objects using tools such as 3D modeling software, 3D printers, and laser cutters.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

4. **Use online learning management systems (LMSs) such as Canvas, Schoology, Moodle, Eliademy for teaching or learning.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

5. **Manage projects online by sharing digital resources, coordinating tasks, and assigning team roles.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

6. **Collaborate online using collaborative tools such as Google Docs, Wiki, and Google Slides, etc.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

7. **Post multimodal articles (e.g., texts combined with images, audio, and videos) in websites.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

8. **Share digital artifacts such as audio and videos through platforms such as YouTube and Vimeo.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

9. **Communicate online with people using online communication tools such as emails, messengers, Skype, and Google Hangouts.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

10. **Use the Internet or social media tools such as Facebook that reflects good digital citizenship.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

11. Exchanging feedback through social media tools or online forums.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

12. Use virus software and other strategies to protect my online identify and privacy.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

13. Search the Web using Google or other engines to find answers or resources.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

14. Ask online when I need help with finding solutions.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

15. Bookmark and save surfing results for the future use.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

Collaboration Survey

1. Participation in group work will help me succeed in my future workplace.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

2. Knowing that other students would view or read my work will motivate me to produce better quality work.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

3. I will learn more as a result of completing projects as part of a team.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

4. Participation in group works will help me develop social relationships with group members.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

5. I like participating in group projects.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

6. I prefer classes that use group work over classes that do not use group work.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

7. My contributions during group work will help other students learn.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

8. My experience with group work during this semester will be satisfactory.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

9. In group work, individual contribution should count more than team contribution.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

10. Problem solving and decision making in group work will be efficient.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

11. Group members will work well together with conflicts that are easily resolved.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

12. Sometimes I will be reluctant to participate in group discussions because of the behavior of other group members.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

13. The quality of completed group project will be better if I work on it individually.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

14. Group work will produce a quality product that meets my satisfaction.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

15. I will be committed to the final product my group produces.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

16. I am confident that group work will result in a high score.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

17. The result of group work will meet or exceed group work requirements specified in the group work instructions.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

18. My input will be reflected in my group's work.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

19. I believe the use of technology will facilitate working in group assignments.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

20. I will use technology tools (such as email, web) effectively to plan meetings.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

21. After meetings I will use technology tools (such as email, web) effectively to discuss/share/follow-up information about what will have been discussed in group meetings

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

Popular Culture Survey

1. I like popular-culture resources to be included in courses.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

2. Popular-culture resources will help me understand technology integration into education better.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

3. Popular-culture resources will make me pay attention to course content.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

4. I will embed popular cultures in my courses when I teach my future students.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

APPENDIX C

Pilot Study Post-Survey

Demographic Survey

1. What is your name: ____________________________

2. What is your UGA email address?
____________@uga.edu

Digital Literacy Survey

Listed below are 15 important digital literacy skills. For each one, please respond in two ways. First, please rate your own skill level of a ten-point scale from 1=Novice to 10=expert. Second, please rate your level of confidence that you can help others (such as future students if you become a teacher) learn this particular digital literacy skill.

1. Creating websites using tools such as New Google Sites, Wix, Wordpress, etc.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

2. Creating digital artifacts such as images, audio, and videos, etc.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

3. Design and make objects using tools such as 3D modeling software, 3D printers, and laser cutters.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

4. Use online learning management systems (LMSs) such as Canvas, Schoology, Moodle, Eliademy for teaching or learning.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

5. Manage projects online by sharing digital resources, coordinating tasks, and assigning team roles.
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

6. **Collaborate online using collaborative tools such as Google Docs, Wiki, and Google Slides, etc.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

7. **Post multimodal articles (e.g., texts combined with images, audio, and videos) in websites.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

8. **Share digital artifacts such as audio and videos through platforms such as YouTube and Vimeo.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

9. **Communicate online with people using online communication tools such as emails, messengers, Skype, and Google Hangouts.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

10. **Use the Internet or social media tools such as Facebook that reflects good digital citizenship.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

11. **Exchanging feedback through social media tools or online forums.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

12. **Use virus software and other strategies to protect my online identify and privacy.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

13. **Search the Web using Google or other engines to find answers or resources.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

14. **Ask online when I need help with finding solutions.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

15. **Bookmark and save surfing results for the future use.**
My skill level: 1=Novice 2 3 4 5 6 7 8 9 10=Expert
Help others: 1=No confidence 2 3 4 5 6 7 8 9 10=Completely confident

Collaboration Survey

1. **Participation in group work will help me succeed in my future workplace**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

2. **Knowing that other students would view or read my work motivated me to produce better quality work.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

3. **I learned more as a result of completing projects as part of a team.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

4. **Participation in my group work helped me develop social relationships with my group members.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

5. **I like participating in group projects.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

6. **I prefer classes that use group work over classes that do not use group work.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

7. **My contributions during the group works helped other students learn.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

8. **My experience with the group work during this semester was satisfactory.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

9. **In group work, individual contribution should count more than team contribution.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

10. **Problem solving and decision making in group work was efficient.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

11. **My group members worked well together with conflicts that were easily resolved.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

12. **Sometimes I was reluctant to participate in group discussions because of the behavior of other group members.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

13. The quality of completed group project would have been better if I had worked on it individually.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

14. My group work produced a quality product that meets my satisfaction.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

15. I am committed to the final product my group produces.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

16. I am confident that my group's work will get a high score.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

17. My group's work meets or exceeds group work requirements specified in the group work instructions.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

18. My group's work does not reflect my input.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

19. I believe the use of technology facilitates working in group assignments.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

20. My group used technology tools (such as email, web) effectively to plan meetings

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

21. After meetings my group used technology tools (such as email, web) effectively to discuss/share/follow-up information about what was discussed in group meetings

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

Popular Culture Survey

1. I like popular-culture resources in the EDIT 2000 course.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

2. Popular-culture resources helped me understand ISTE standards better.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

3. Popular-culture resources made me pay attention to course content.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

4. I will embed popular cultures in my courses when I teach my future students.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

APPENDIX D

Pilot Study Interview Questions

1. Tell me about your overall experiences in EDIT 2000.
   -What was positive?
   -What was challenging?
2. How did the EDIT 2000 course help you improve your digital literacies about communicating better with people through technologies?
3. How can you help your future students communicate better with people through technologies?
4. How did the EDIT 2000 course improve your competency to collaborate better with people through technologies?
5. How can you help your future students collaborate better with people through technologies?
6. How did the EDIT 2000 course improve your competency to create digital artifacts such as images, audio, videos, and 3D modeling?
7. How can you help your future students create digital artifacts such as images, audio, videos, and 3D modeling?
8. How did the EDIT 2000 course improve your competency to publish online what you wrote or created?
9. How can you help your future students publish online what they wrote or created?
10. How did the EDIT 2000 course help you establish proper digital citizenship?
11. How can you help your future students establish proper digital citizenship?
12. How did the EDIT 2000 course help you improve your problem-solving skills with information searching, computational thinking, and design thinking?
13. How can you help your future students improve their problem-solving skills with information searching, computational thinking, and design thinking?
14. How did you like the methods of forming groups in the course?
15. What do you think are important factors for successful group work?
16. Did you find any difficulties in the collaborative activities? Why/why not?
17. How did collaborative activities help you learn better?
18. (Showing one of the collective knowledge building activities) How did you like these collective knowledge building activities? Do you think your group actively interacted with each other? Why or why not?
19. In the collective knowledge building activities, most of the group did not interact actively. Could you explain the possible reasons for low interaction?
20. Do you think if I provide this kind of collaboration script (showing example of collaboration script) to students, their interaction will improve?
21. (Showing collaboration script – Robotics Challenge) Do you think this collaboration script helped your group interact better? Why? Why not? How?

22. (Showing collaboration script – Commercial Tool) Do you think this collaboration script helped your group interact better? Why? Why not? How?
23. (Showing collaboration script – MOOC) Do you think this collaboration script helped your group interact better? How? Why not?
24. How can I make the collaboration processes in the course more active?
25. Do you think that group work can result in a better quality of work than individual work? Why/why not?
26. Do you think that working in groups for the tool commercial project helped you improve your digital literacies better than working individually? Why? Why not?
27. Do you think that working in groups for the MOOC project helped you improve your digital literacies better than working individually? Why? Why not?
28. How did you like popular culture in the course?
29. (Showing popular cultural activities) How did these popular culture activities help you construct knowledge together about digital literacies such as communication, collaboration, and digital citizenship?
30. Do you think these popular culture activities successfully grabbed your attention for digital literacy practice domains?
31. Will you use popular cultures when you teach? Why? Or Why not?
32. How can the current EDIT 2000 course be improved regarding collaborative activities?
33. How can the current EDIT 2000 course be improved regarding popular cultural activities?

APPENDIX E

Pilot Study CSCL Guides for Robotics Challenge

Team Strategy for Robot Challenge

To win the Robot Challenge competition, your team needs to understand the task, rubric, map, and block programming. Each team will have four or five members and two computers. According to the rubric, your task result will be scored. The following guide will help your team organize your collaborative efforts. Please fill in the form before you start programming.

Your Team Name: **Team Members**:

Role	What to do
Programmer 1 Name:	You take charge of one computer. You need to communicate and collaborate effectively with other team members. Especially you need to collaborate with the other programmer in your team. • Open the Rogic program on your computer. • Your team needs computational thinking to complete the task effectively. • Identify sequences / develop your robot program a little bit / try it out / develop more / save what you programmed to your computer / reuse and remix what you already programmed.
Programmer 2 Name:	You take charge of another computer. You do the same thing as Programmer 1. You need to work closely with Programmer 1.
Analyzer Name:	You are the task and rubric analyzer. You need to communicate the content of the task and rubric to your team members so that they can understand what to do to complete the task. Especially you need to communicate well with the programmers to let them know how and where the robot should go to earn points.
Robot Controller Name:	You take charge of the robot. If your team has four members, you will also play the role of the director. You need to the following: • Locate the power button, USB outlet, and USB cable of your robot. • Check your robot and make sure that it works. • If your robot needs battery change, ask the instructor to give you new batteries. • Connect your robot to one of the Programmers' computers and download the programed file onto the robot.

	Try it out repeatedly on the map until your team completes the task.
Director Name:	You are like a coach of a football team. You need good communication and collaboration skills to do the following: - Communicate with the Analyzer, Robot Controller, and the two Programmers to decide on the robot's next move. - Orchestrate programs on the two computers so that your team ends the task quickly. - When you are done, ask the instructor to assess your task result.

APPENDIX F

Pre-Survey

Demographic Survey

1. Name: ______________________________

2. UGA email address: ___________________@uga.edu

3. Age in years: ________ years

4. What is your academic major? (Or if you have not decided yet, which academic major do you want to pursue?)

____

Digital Literacy Survey

Digital Literacy Knowledge and Skills

Listed below are questions about your knowledge and technological skill levels in reference to important digital literacy practices. For each question, please respond in three ways. First, please rate your own knowledge of each type of digital literacy on a ten-point scale from 1=Novice to 10=Expert. Second, please rate your technological skill level for each type of digital literacy on a ten-point scale from 1=Novice to 10=Expert. Third, please rate your level of confidence that you can help others (such as future students if you become a teacher) learn this particular type of digital literacy knowledge and technological skill.

1. **Communicating with others using diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

2. **Collaborating with others using diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

3. **Creating digital artifacts such as video, audio, and images**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

4. **Publishing digital artifacts such as video, audio, and images**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

5. **Participating in responsible forms of digital citizenship**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

6. **Conducting research with diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

7. **Solving real world problems with diverse technologies by employing design thinking.**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

8. **Solving real world problems with diverse technologies by employing computational thinking**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

Attitudes toward Digital Literacy Education

Please indicate your level of agreement (or disagreement) with respect to the following statements about digital literacy education.

9. **Teaching K-12 students how to use technology for communication is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

10. **Teaching K-12 students how to use technology for collaboration is very important**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

11. **Teaching K-12 students how to create digital artifacts is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

12. **Teaching K-12 students how to publish digital artifacts is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

13. **Teaching K-12 students to engage on responsible digital citizenship is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

14. **Teaching K-12 students how to solve problems with the help of technology is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

15. How would you describe your current motivation toward learning more about digital literacy?

16. What concerns, if any, do you have about developing more digital literacy knowledge and enhanced technological skills?

APPENDIX G

Post-Survey

Demographic Survey

1. Name: ____________________________

2. UGA email address: __________________@uga.edu

Digital Literacy Survey

Digital Literacy Knowledge and Skills

Listed below are questions about your knowledge and technological skill levels in reference to important digital literacy practices. For each question, please respond in three ways. First, please rate your own knowledge of each type of digital literacy on a ten-point scale from 1=Novice to 10=Expert. Second, please rate your technological skill level for each type of digital literacy on a ten-point scale from 1=Novice to 10=Expert. Third, please rate your level of confidence that you can help others (such as future students if you become a teacher) learn this particular type of digital literacy knowledge and technological skill.

1. **Communicating with others using diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

2. **Collaborating with others using diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

3. **Creating digital artifacts such as video, audio, and images**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

4. **Publishing digital artifacts such as video, audio, and images**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

5. **Participating in responsible forms of digital citizenship**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

6. **Conducting research with diverse technologies**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

7. **Solving real world problems with diverse technologies by employing design thinking.**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

8. **Solving real world problems with diverse technologies by employing computational thinking**

My knowledge level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
My technological skill level	**Novice**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Expert**
Confidence in helping others	**None**	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	**Full**

Attitudes toward Digital Literacy Education

Please indicate your level of agreement (or disagreement) with respect to the following statements about digital literacy education.

9. **Teaching K-12 students how to use technology for communication is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

10. **Teaching K-12 students how to use technology for collaboration is very important**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

11. **Teaching K-12 students how to create digital artifacts is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

12. **Teaching K-12 students how to publish digital artifacts is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

13. **Teaching K-12 students to engage on responsible digital citizenship is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

14. **Teaching K-12 students how to solve problems with the help of technology is very important.**

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

15. How would you describe your current motivation toward learning more about digital literacy?

16. What concerns, if any, do you have about developing more digital literacy knowledge and enhanced technological skills?

Collaboration and Resources Survey

Listed below are questions about your experiences engaging in collaboration and using diverse resources during the technology genius project. Please rate your opinions about each question on a five-point scale. Then, please add your explanatory comments after each question.

17. **Please rate the extent to which each of these collaborative activities helped you improve your digital literacy knowledge and skills.**

Co-creating a website	No help	①	②	③	④	⑤	Very helpful
Co-constructing Google Docs	No help	①	②	③	④	⑤	Very helpful
Co-creating infomercial video	No help	①	②	③	④	⑤	Very helpful
Co-creating lesson plans	No help	①	②	③	④	⑤	Very helpful
Collaborative technology force activity	No help	①	②	③	④	⑤	Very helpful
Viewing the work of other groups	No help	①	②	③	④	⑤	Very helpful
Feedback from other classmates	No help	①	②	③	④	⑤	Very helpful

Please add explanatory comments here.

18. **Please rate each aspect of collaboration during the technology genius project.**

Communication in the project	Inactive	①	②	③	④	⑤	Very active
Collaborative teamwork	Very Dissatisfied	①	②	③	④	⑤	Very satisfied
The quality of the final product	Very Dissatisfied	①	②	③	④	⑤	Very satisfied

Please add explanatory comments here.

19. **Please rate to which extent the collaboration guides facilitated collaboration.**

The facilitation of collaboration guides in collaboration	No effect	①	②	③	④	⑤	Strong effect

Please add explanatory comments here.

20. **Please rate the extent of how useful each of these resources helped you improve your digital literacy.**

Question prompts / Guiding questions	No use	①	②	③	④	⑤	Very useful
Digital literacy resources	No use	①	②	③	④	⑤	Very useful
Popular culture (movies / pop songs)	No use	①	②	③	④	⑤	Very useful

Please add explanatory comments here.

Thank you!

APPENDIX H

Interview Protocol

Topic #1: Digital Literacies

Leadoff and possible follow-up questions:

1. Tell me about your overall experiences in the Technology Genius Project.
   1.1. What was positive?
   1.2. What was challenging?
2. What knowledge did you learn through the Technology Genius Project?
   2.1. How did you learn the knowledge your described through the Technology Genius Project?
   2.3. Tell me more about your knowledge of creating / publishing / communicating / collaborating / digital citizenship / research with technology.
   2.2. Which knowledge do you like best? And why?
3. What skills did you learn through the Technology Genius Project?
   3.1. Tell me more about how you learned the digital literacy skills.
   3.2. Tell me more about your digital literacy skills related with creating / publishing / communicating / collaborating / digital citizenship / research with technology.
   3.3. Which digital literacy skills do you like best? And why?
4. Tell me about your experiences in creating lesson plans during the technology genius project.
   4.1. How can you help K-12 students improve their digital literacies?
   4.2. What did you learn from other students' lesson plans?

Covert Categories: Attitudes about digital literacies, digital literacy development, knowledge / skills about each digital literacy practice domain, meaningful integration of technology into education, feedback about the Technology Genius Project

Topic #2: Collaboration

Leadoff and possible follow-up questions:

1. Tell me about your overall experiences in collaboration during the Technology Genius Project.
   1.1. What was positive?
   1.2. What was challenging?
2. Tell me about how your group interacted with each other for the project
   2.1. What was positive?
   2.3. What was challenging?

3. Tell me about your experiences in giving your feedback to other groups' work / receiving feedback from other students.
    3.1. What was positive?
    3.2. What was challenging?
4. Tell me about your experiences in collaboration guides provided by the instructor.
    4.1. How did collaboration guides influence collaboration processes?
    4.2. What was positive / challenging?
5. Tell me about your experiences in question prompts provided by the instructor
    5.1. How did the question prompts influence your learning?
    5.2. How did the questions prompts influence your collaboration?
6. Tell me about your experiences in resources provided by the instructor.
    6.1. How did the resources influence your learning?
    6.2. How did the resources influence your collaboration?

Covert Categories: Satisfaction with group formation, learning from collaboration, attitudes about collaboration, satisfaction with collaboration guides / prompts / resources

Topic #3: Popular culture

Leadoff and possible follow-up questions:

1. Tell me about your overall experiences in popular-culture resources in the Technology Genius Project.
    1.1. What was positive/challenging?
    1.2. What did you like most among the popular-culture resources?
2. What did you learn from popular culture?
    2.1. How did popular cultural content influence your learning processes?
3. How did popular culture influence collaboration processes?
    3.1. What was positive?
    3.2. What was challenging?

Covert Categories: Satisfaction with group formation, learning from collaboration, attitudes about collaboration, satisfaction with collaboration guides / prompts / resource

APPENDIX I

Rubric for the TGP Products

1. WEBPAGE PEER ASSESSMENT

Webpage Components	**Items**	**Points**
Explanations about digital literacy practice domain (25)	It is composed of the combination of texts and videos or texts and images	No – 2.5 point / Yes - 5 point
	It answers the guiding questions (question prompts) very well.	1- misses four questions 3- misses three questions 6- misses two questions 8- misses one question 10- answers every question
	The section satisfies the minimum word count requirement (500 words)	Less than 200 words – 1 200 – 299 words – 3 300 – 399 words – 6 400 – 499 words – 8 500 words and more – 10
Video commercials for their chosen tools (30)	The tool commercial proposal was constructed well enough	Minimum- 1 / Maximum- 5
	The tool commercial section in the webpage has a well explained introductory texts which explains what tools the group advertise, why they chose the tools, and what features of the tool they emphasize.	Minimum- 1 Maximum- 5
	The video is embedded in the section.	Embedded – 5 / Linked – 2
	The video is appealing to k-12 educators.	Minimum- 1 / Maximum- 5
	The video is addressing how the tool supports the group's specific digital literacy domain by explaining characteristics of the tool.	Minimum- 1 / Maximum- 5
	The length of the video	30 to 120 seconds - 5 Less than 30 – 2.5 More than 120 - 2.5

Lesson Plan (25)	Every component of lesson plan form was filled out	Missing component – 2.5 Complete – 5
	The lesson plan has the characteristics of meaningful integration of technology	Minimum- 1 Maximum- 5
	The activities are described well enough	Minimum- 1 / Maximum- 5
	The lesson plan is appealing to K-12 teachers	Minimum- 1 / Maximum- 5
Your Feedback (20)	This feedback is evaluated by the instructor.	More than 20 constructive feedbacks – 20 points, 15 –19: 15 points, 10 – 14: 10 points, 5 – 9: 5 points, 1 – 4: 2 points

2. **Rubric for the TGP individual knowledge building assignments**

Objective/Criteria	**Unsatisfactory**	**Need Improvement**	**Meet Expectations**
Focus Question	(30 point) Vaguely addresses the focus questions.	(60 points) Focus questions are not addressed well enough.	(80 points) Focus questions are fully addressed.
Timeliness	(2 points) Two days late (0 point) More than two days late	(5 points) One day late.	(10 points) On time.
Length	(2 points) 100-129 words (0 point) Less than 100 words	(5 points) 130-179 words	(10 points) Minimum 180 words

APPENDIX J

Observation Protocol

Date:
Class hour:
Location:
Title of the lesson:
Observation focus:
Observation No.:

	Diagram of student' groups:	
Time:	Descriptive notes	Reflective notes (OC)

Note. Adapted from "Qualitative inquiry and research design: Choosing among five approaches (2nd ed.)" by Creswell (2007, p. 137). Thousand Oaks, CA: Sage.

APPENDIX K

Question Prompt Examples

1. Collaborative knowledge building question prompts for communication group on the Model/Guidance Web site

In this section or following sections, please answer the following questions:

- What is the question your group wants to investigate about the digital literacy practice of communication? Please answer your group's question.
- What is communication using technology?
- What are communication processes?
- What makes communication difficult?
- How can teachers communicate with students and parents effectively using technologies?
- What are tools for communication?
- What are your favorite communication tools? And why?

2. Individual knowledge building question prompts for communication group

TGP: Assignment 1 – Communication (Due on before class on 9/13 [Thursday])

(Due date: Before class on 9/13) Read read one of two pages (wikipage or kidcourse) and watch the clip of the movie *Arrival* (Password protected: Ask your instructor). Some of you may want to read Ted Chiang's short story "Story of your Life," which is the original story of the movie *Arrival.* Please answer the following questions through the Google Form below. Please refer to this rubric before you submit your reflections.

1.What is communication and what makes communication difficult?

2. If you were in the film *Arrival*, how would you communicate with a Heptapod. If you would use any technology for communication with the Heptapod, what would it be?

3. Below are tools for communication. What are your favorite tools among them?

4. What kinds of communication activities can you do with your favorite tools if you teach K-12 students?

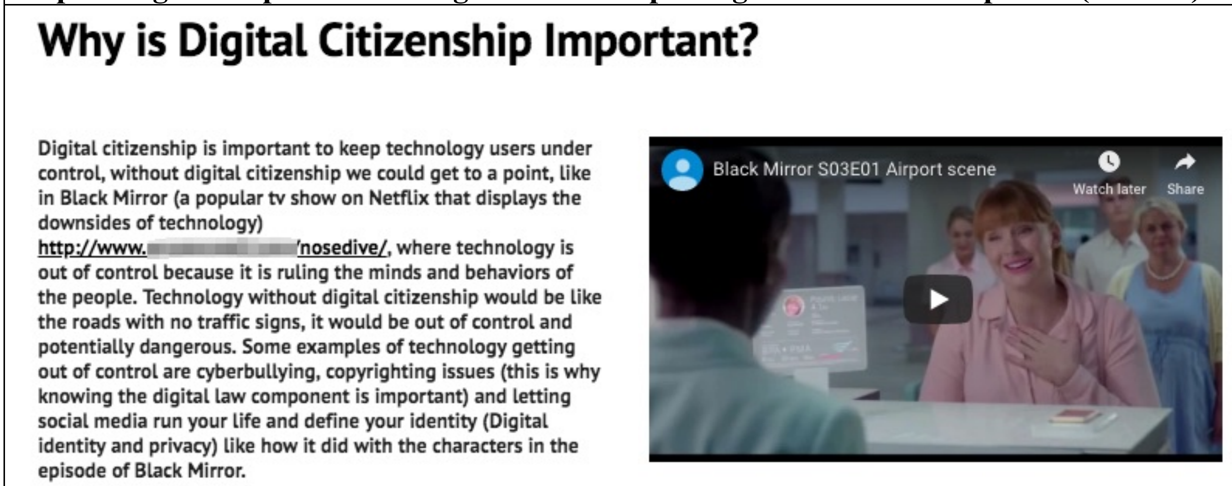
References

Chiang, T. (2010). *Stories of Your Life and Others* (Reissue edition). Vintage. Amazon Kindle PC version.

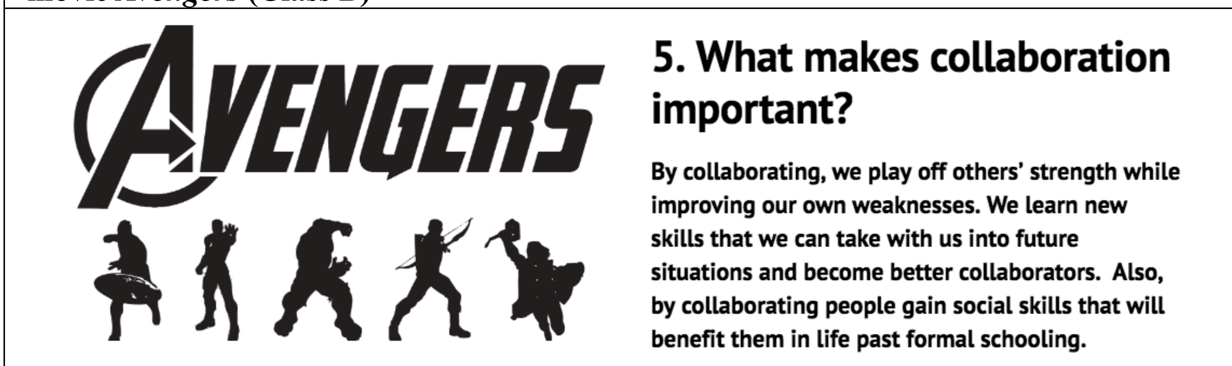
APPENDIX L

Participants' Popular Culture Incorporation into their Products in Classes B and C

Explaining the importance of digital citizenship using the "Nosedive" episode (Class B)



Explaining collaboration using the image regarding the movie *Avengers* (Class B)



Explaining collaboration using *Avengers* (Class C)

Collaboration is important because when we create things together we have multiple perspective that can lead us closer to the truth of what we are attempting to produce and release into the world. In the state of nature, man needed collaboration in order to survive. Many animals were stronger and could, therefore, physically overpower any individual human. It wasn't until humans used their intellect and collaborated that they were able to become the most dominant species. Another example could be drawn from the movie The Avengers, where each hero plays a role in defeating a overpowered villain. It is in a collaborative effort that the avengers are able to defeat such a villains.

Explaining digital citizenship using "Nosedive" episode (Class C)
What makes digital citizenship important? How you act on social media can affect other people's lives. In the Black Mirror episode, Nosedive, each person in that society has an online profile and rating that is determined based on how people feel about you. Each person's score can go up or down depending on each interaction they have and how the person they interacted with sees them. For instance, when you treat someone poorly on social media, it doesn't only negatively affect the person you treated poorly, it reflects on you. In the episode, the importance of treating people kindly on social media was exemplified through seeing the negative effects on the main character for not doing so. Although in real life we don't have actual online ratings that change with each interaction, people's internal opinions about you can still change depending on how you act online. Overall, digital citizenship is important because it affects others but reflects on you.
Explaining digital citizenship using "Nosedive" episode (Class C)

What kinds of practices in education do you want to improve through your research?

Improving upon the method of activities solely following audio-visual instruction. Learning through this method has been proven to prove not as fruitful as empowering students to learn through technology. As we viewed the music video for Another Brick in the The Wall, the current educational system leads to desensitization among learners, and lacks true engagement. Educators can improve upon this practice by allowing their students to use research tools such as Evernote or GoogleDrive during class time.

Explaining problem solving using the movie *The Imitation Game* (Class C)

Problem solving is a complex process used to answer a question or resolve an issue involving 4 steps. These four steps are:

1. Defining the problem, where you define the problem
2. Generating alternatives, where you come up with alternative options
3. Evaluating and selective alternative modeling, where you choose the best alternative option
4. Implementing solutions, where you use the alternative option as a solution to the problem.

An example of problem solving was used during the movie *Imitation Game* when the men went through all the steps required to understand the code. They understood that the code would bring them answers that would be beneficial for the war. They begin decoding the message and coming up with different solutions based on the code.

APPENDIX M

Published Webpage Example

1. What tools assist students gaining knowledge in a collaborative setting?

There are so many tools available for students to use to gain knowledge in a collaborative setting. Some popular tools are Google Docs, Padlet, Skype, Mural, and more. These tools all allow people to communicate and share their ideas on certain assignments and tasks.

There are also more specialized tools like StudyRoom, Piazza, Minecraft, Mindmeister, and others that provide a very specific, collaboration based experience. For example, StudyRoom is a website that allows students to share notes, study guides, and solutions to homework. It also permits students to form study groups that are helpful for tests. The students can get together and share their knowledge and ideas. They can collaborate and work together to understand topics that they may not have understood before to meeting to become solid on them before the test. All of these tools are helpful in advancing students ability to collaborate with others.

2. What is collaboration?

Working together to achieve a common goal. This can be done by participating in discussions, over the phone communication, or attending meetings to discuss the task at hand. The student is not simply listening to the conversation, they are adding their opinion and knowledge to the conversation.

Being able to utilize the diversity and skills of a group to complete a certain task or reach a specific goal. There are also many subtle nuances that come along with collaboration. Things like the role of each individual, the group dynamic, how well the members function as a team, and many other aspects are all encompassed by collaboration.

Click here to learn more about collaboration

The Importance of Collaboration

3. What is the difference between collaboration and cooperation?

COLLABORATION

In collaboration, people work towards a goal with a similar level of expertise. Collaboration provides more opportunity for one to display their own strengths rather than follow instruction.

COOPERATION

In cooperation, there is a teacher/student environment and one learns how to accomplish a task from another source. It is a mentor/men-tee dynamic versus a group setting.

4. How do theories support collaboration? [e.g., Vygotsky]

Vygotsky stated that we learn best through interaction with experts, teachers, and each other. He said that social learning precedes development. Vygotsky promotes learning where the students take an active role, teacher and student should collaborate to facilitate the meaning of learning.

Click here to learn more about Vygotsky

5. What makes collaboration important?

By collaborating, we play off others' strength while improving our own weaknesses. We learn new skills that we can take with us into future situations and become better collaborators. Also, by collaborating people gain social skills that will benefit them in life past formal schooling.

6. What are the digital tools for collaboration?

According to the course website, the list is:

G Suite, Mindmap, Online Walls/Boards, Others, Google Classroom, MindMeister, Mural.ly, MinecraftEdu, Google Docs, Okmindmap, Padlet, Bookcreator, Google Slides, Mindomo Invision, (Design+Online wall), PrimaryPad, Google Sheets, Lino, Google MyMaps, Google Drawings, Realtime Board, Diigo

However, there are many more collaboration tools out there, each one with it's own unique and specific purpose.

Many digital tools offer similar functions, but are geared for slightly different purposes. Take for example Slack and Remind. While both are group messaging programs, Slack is more geared towards businesses/organizations while Remind is more geared towards a classroom setting.

7. What are your favorite collaboration tools? why?

Google Docs/Sheets, because it is easy to share information and collaborate with others to create a single document or project. Students can use google Docs/Sheets to collaborate by compiling their ideas together in order to accomplish the assignment. Google Docs can be incorporated into the classroom in so many ways. For example, the teacher could assign the students an online worksheet and the students could work with each other in order to complete the worksheet. Another way to incorporate google docs into the classroom is if the teacher created a study guide online and shared it with the students. Google Docs would

8. Collaboration Tool Commercial: Google Drive

Google Drive is a tool that allows students to collaborate and work on assignments in real time. This tool lets people share their ideas and work together without necessarily being face to face. Google Drive also has many different aspects to it that can be usefu for almost any assignment. There is Google Sheets (for logging data and creating graphs), Google Docs (for completing online worksheets and writing/editing essays), and Google Slides (for creating presentations). Another feature of Google Drive is that it automatically saves the work that you have completed, therefore even if your computer crashes, you and your group members' wor will be successfully saved. Lastly, Google Drive is accessible from any device. It can be loaded from an iPhone, Mac, PC, and so muc more. You can work on the go or in the comfort of your own home. Overall, Google Drive is a great resource for all students and teachers to use. The aspect of collaboration is excellent by allowing students to work together in real time.

9. Collaboration Lesson Plan

Collaboration Lesson Plan

Subject: Social Studies
Title of Lesson: Virtual Field Trip and Presentation
Standard: SS6G1 Locate selected features of Latin America. • Locate on a world and regional political-physical map: Amazon River, Amazon Rainforest, Caribbean Sea, Gulf of Mexico, Atlantic Ocean, Pacific Ocean, Panama Canal, Andes Mountains, Sierra Madre Mountains, and Atacama Desert.

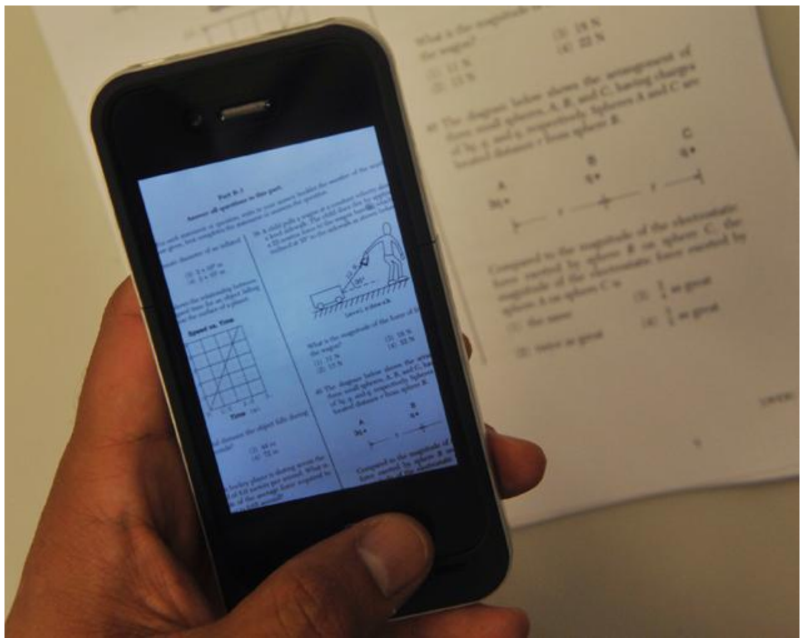
APPENDIX N

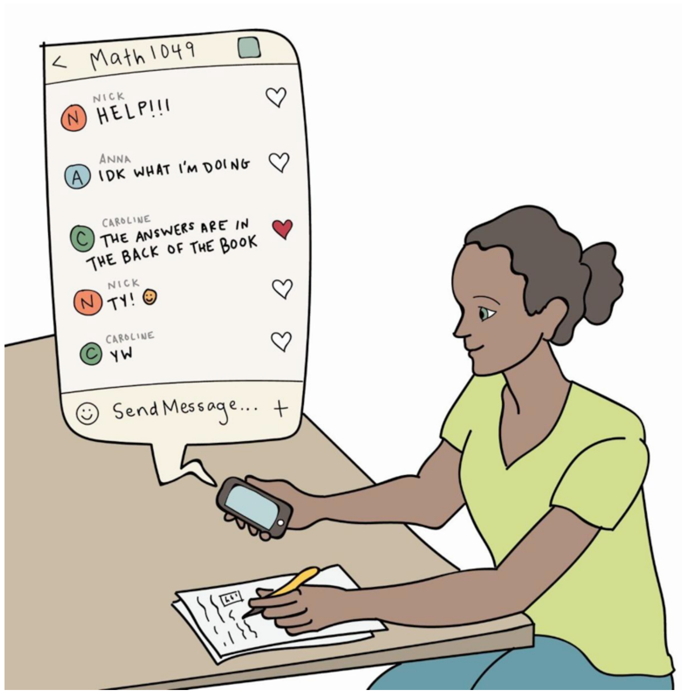
Video Commercial Plan of the Digital Citizenship Group from Class C

Video Commercial Plans for K-12 teachers

1. Your team members	
2. Tool name to advertise	GroupMe
3. Why did you decided to advertise this tool?	GroupMe is a great source for students to broaden their own knowledge while using the knowledge of their peers. Everyone has something to offer and in this group communication setting, it provides the opportunity for everyone to learn from fellow students. It is also user friendly and easily accessible.
4. Key functions of your tool	GroupMe offers an easy way to communicate with others through group and personal messaging, online polls, reminders of important dates with the calendar function, meme creation, and media sharing. It is easily accessible for all students through the GroupMe app or online through a computer.
5. How are the key functions related to your team's digital literacy domain?	The communication function of this tool aids people in enhancing their digital citizenship as it is above defined. It allows users to practice digital citizenship while participating in group chats, for example, because it is a place where the components of digital citizenship are important; it is imperative that someone is honest, respectful, aware, and considerate while using GroupMe.
6. Video editing Tools to create infomercial	We will be using iMovie to edit our infomercial.

7. Storyboard for infomercial (writing, drawing, or photos, or combinations of these)	We are going to do somewhat of a dramatic infomercial with students showing poor and excellent digital citizenship. We would see students sending a picture of their answers on a test in GroupMe. Students would respond correcting the academic dishonesty and pointing out that the other students aren't using good digital citizenship. The students who used the technological platform incorrectly would then show that they learned their lesson. We would cut to the same students in the future using GroupMe and digital citizenship correctly by helping each other find the answers on their own. (as seen below) 

	Then we cut to GroupMe.  We would see students sending a picture of their answers on a test in GroupMe. Students would respond correcting the academic dishonesty and pointing out that the other students aren’t using good digital citizenship. The students who used the technological platform incorrectly would then show that they learned their lesson. We would cut to the same students in the future using GroupMe and digital citizenship correctly by helping each other find the answers on their own. (as seen below)



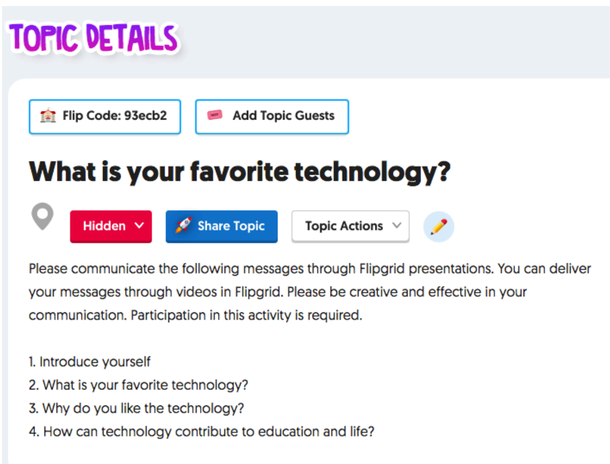
Then we cut to GroupMe again and have a voice over saying something along the lines of “groupme- forming good digital citizens everywhere” or something cheesy like that.

The end.

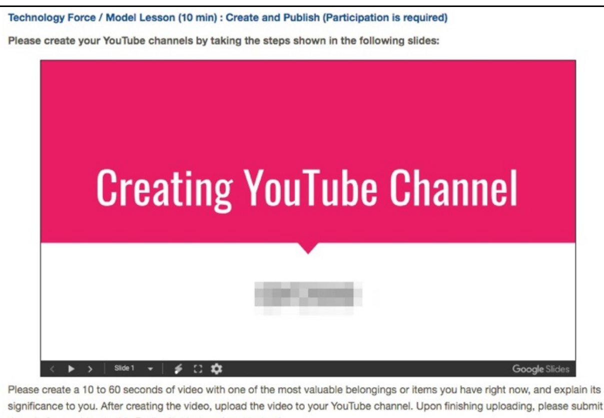
APPENDIX O

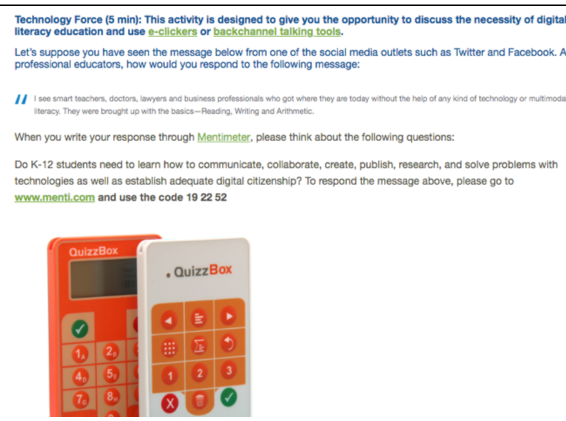
Tech force/Model lesson

Communication (Flipgrid)	Collaboration



Creating/Publishing/Digital Citizenship	Attitudes toward digital literacies



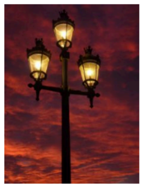


<table>
<tr><th>Problem solving</th><th>Research</th></tr>
<tr><td>

Tech Force / Model Lesson (10 min.):

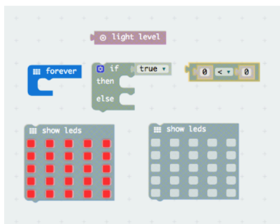
Microbit Challenge (Group Work)

Many street light turns on automatically when they sense that sun light is less than a specific level. Today, you will program a street light which turns on when the light level is less than 50.



Go to Microbit site and click "Let's Code" on the menu

The following code blocks are what you need to program the street light. You have multiple components at work here: light level, forever, if, math, and two LED light blocks. One of LED light block should be turned on. Please combine the blocks to complete your task.



Star Wars Challenge: Code.org (Individual Work, 5 minutes)

Go to this page. You can "build a galaxy with code" there. You can choose between two options: Blocks and Javascript. You may find that Blocks are easier, but you can also choose Javascript blocks. Please try to finish as many stages as you can for 5 minutes. If you have the remaining time, try to finish all the stages!

Reflections: Think about how you can help K-12 students with the digital literacy practice of doing research and solving problems.

</td><td>

Technology Force / Model Lesson (10 min): Search the Web

Please complete the following task:

1. Some people say that the company with the following logo will make a great impact on the human future. However, you do not know which company this is. Please find out the company name and what the company has achieved so far. You can search the company using one of the tips found in this page. Share your opinion about how the work this kind of company is doing can influence education, business, law, journalism, and healthcare ([redacted]).

Which company?

2. Let's suppose you are researching how you can implement a Flipped Classroom. There may be many articles about the topic. Search information about Flipped Classrooms and store the articles themselves, url of the articles, or screen captures of them to one of your digital notes such as Google Keep, One note, and Evernote. Write a your opinion about how a Flipped Classroom could influence education positively or negatively on your digital note where you stored the articles, urls, or screen captures. Finally, share your digital note by inviting me ([redacted]) or through this Padlet ([redacted]

Flipped Classroom

</td></tr>
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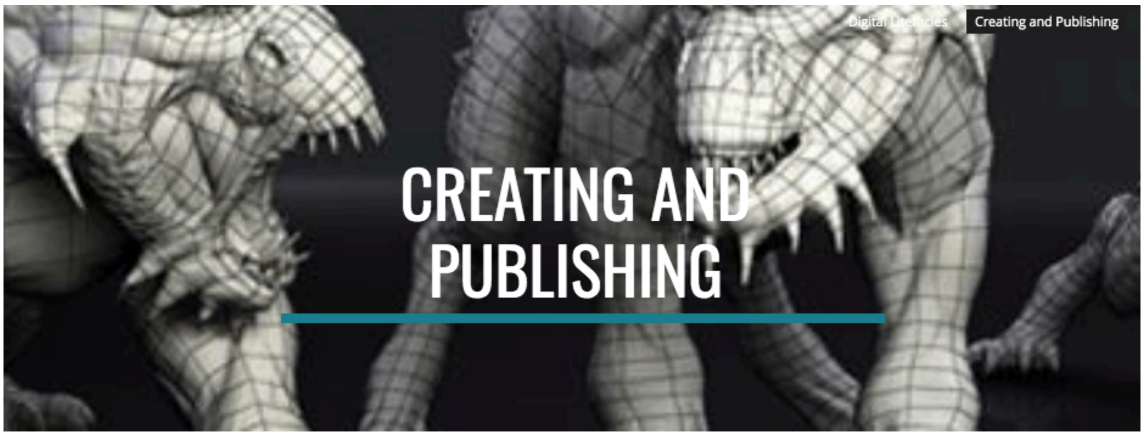
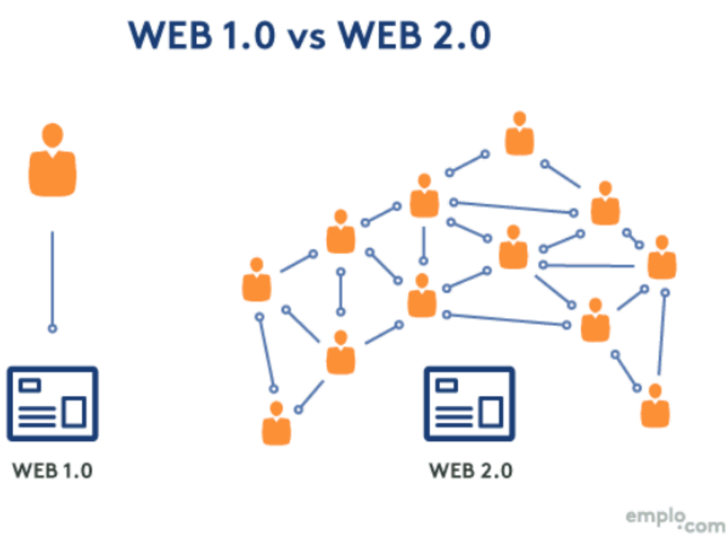
APPENDIX P

A Section of Published Webpage of the Creating and Publishing Group (Class A)





1. WHAT IS THE QUESTION YOUR GROUP WANTS TO INVESTIGATE ABOUT THE DIGITAL LITERACY PRACTICE OF CREATING AND PUBLISHING?

Are there any specific ways individuals can improve their digital literacy in order to create/publish with technology?

APPENDIX Q1

Lesson Plan of the Creating and Publishing Group from Class A

<table>
<tr><td colspan="2">Subject: Science</td></tr>
<tr><td colspan="2">Title of Lesson: Cell Structure 3D Model Development</td></tr>
<tr><td colspan="2">Standard:
S7L2. Obtain, evaluate, and communicate information to describe how cell structures, cells, tissues, organs, and organ systems interact to maintain the basic needs of organisms.</td></tr>
<tr><td>Activity Duration: 4 weeks</td><td>Grade Level: 7th Grade</td></tr>
<tr><td colspan="2">Technologies: Tinkercad, Google Slides, & Prezi</td></tr>
<tr><td colspan="2">Objectives:
Students will develop a model and construct an explanation of how cell structures (specifically the nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, and mitochondria) contribute to the function of the cell as a system in obtaining nutrients in order to grow, reproduce, make needed materials, and process waste.
Students will develop and use a conceptual model of how cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms.</td></tr>
<tr><td colspan="2">Meaningfulness of this lesson:
Students are using intentional learning in this lesson plan because they are given a goal (to create a 3D cell model) that they must achieve. When students use technologies, such as Tinkercad, they are using skillful planning to construct the model that they have designed themselves. During this lesson students are actively engaged in meaningful learning because can manipulate the shape and size of the model; therefore, active learning is being used as well.</td></tr>
</table>

Activity Description
1. Students will create a Tinkercad account to design their own 3D model of the human cell with each of its organelles inside. Tinkercad it easy to sign up and it's free for students. Students must remember their username/password for Tinkercad because they will be logging on several times to work on their 3D model. 2. Each 3D model should contain all of the following cell parts/organelles: nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, and mitochondria). Students can refer to classroom materials and other outside sources when creating the 3D model and its organelles. Students should be creative, this assignment is a great way for students to express their creativity. 3. Students will be working on their 3D model for two weeks, so that students can include as much detail into their design as they desire. After two weeks, students should have the majority of the model completed. Then, students will move on to work on the “key” and Google Slide or Prezi. 4. Students should create a “key” that includes a picture of each organelle, so that the students can correctly label and memorize the corresponding organelles that they created in the 3D model. The “key” can be created on the computer or it can be drawn by the student. This step is important for students to learn to recognize each of the cell’s organelles. 5. Each student will create a Google Slide or Prezi to discuss the functions of each of the cell parts/organelles; therefore, each slideshow should contain at least 7 slides to incorporate each of the 7 cell parts/organelles listed above. It is important for students to learn the function of each of the cell’s organelles so they understand how the cell functions as a whole. 6. After everyone completes their Google Slide or Prezi, students will have the opportunity to log onto Tinkercad and view their classmate’s 3D model designs of their cell/cell’s organelles. This gives students the opportunity to look at their classmate’s creativity, and to spark new ideas for other students. 7. Students will briefly present their Google Slides or Prezi to the class, so that everyone has an understanding about how the cell and its organelles function.

APPENDIX Q2

Lesson Plan of the Collaboration Group from Class B

Subject: Social Studies
Title of Lesson: Virtual Field Trip and Presentation
Standard: SS6G1 Locate selected features of Latin America. • Locate on a world and regional political-physical map: Amazon River, Amazon Rainforest, Caribbean Sea, Gulf of Mexico, Atlantic Ocean, Pacific Ocean, Panama Canal, Andes Mountains, Sierra Madre Mountains, and Atacama Desert. • Locate on a world and regional political-physical map the countries of Brazil, Chile, Colombia, Cuba, Mexico, and Panama. SS6G3 Explain the impact of location, climate, distribution of natural resources, and population distribution on Latin America. • Explain how the location, climate, and distribution of natural resources impact trade and affect where people live in Mexico, Brazil, and Cuba. SS6G7 Locate selected features of Europe. • Locate on a world and regional political-physical map: the Danube River, Rhine River, English Channel, Mediterranean Sea, European Plain, the Alps, Pyrenees, Ural Mountains, and Iberian Peninsula. • Locate on a world and regional political-physical map the countries of France, Germany, Italy, Russia, Spain, Ukraine, and United Kingdom. SS6G9 Explain the impact of location, climate, natural resources, and population distribution on Europe. • Compare how the location, climate, and natural resources of Germany, the United Kingdom and Russia impact trade and affect where people live. SS7G5 Locate selected features in Southwest Asia (Middle East). • Locate on a world and regional political-physical map: Euphrates River, Jordan River, Tigris River, Suez Canal, Persian Gulf, Strait of Hormuz, Arabian Sea, and Red Sea. • Locate on a world and regional political-physical map: Afghanistan, Iran, Iraq, Israel, Kuwait, Saudi Arabia, Syria, Turkey, Gaza Strip, and West Bank. SS7G7 Explain the impact of location, climate, physical characteristics, distribution of natural resources, and population distribution on Southwest Asia (Middle East). • Describe how the deserts and rivers of Southwest Asia (Middle East) impact trade and affect where people live.

Activity Duration: 3 Hrs. (3 class periods) 1 hr- virtual tour 1 hr- work on google doc and google slide presentation 1 hr- group presentations, each presentation will be 20 minutes	Grade Level: 6-7 grade

Technologies: Google Earth-Google Maps and Google Drive (Google Docs, Google Slides)

Objectives: Gain proficiency in Google Maps and Google Earth and be able to describe the aforementioned geographical features of foreign regions (Southwest Asia, Europe, and Latin America. Also, they will gain skills using google docs and google slide to compile and present the information they gathered through the activity.

Meaningfulness of this lesson: This lesson will allow students to work actively, intentionally and collaboratively. Students will be learning actively through being engaged by the virtual tour. They will learn intentionally because the assignment is goal oriented, the end goal is a completed presentation. Lastly, they will be able to learn collaboratively by working together and using one another's personal strengths to complete the project.

Activity Description

Students will essentially take a virtual field trip using google earth. The assignment can be made easier or harder depending on the age and competence of the students. First, the students will be divided into groups. One group will explore the geographic features of Southwest Asia, one group will explore the geographic features of Europe, and the last group will explore the geographic features of Latin America. They will be asked to locate specific landmarks and physical features that will allow the students to understand and see how their society functions. Using google earth the students will be able to explore the landscape and physical geography of the country. This assignment allows them to visually explore a place they would not have seen without this activity. It will also give students the ability to locate other places within the region that they have learned about in past years.

After the virtual tour, the students will do research on the area that their group was assigned. The research will explain the implications of the regions location, and how their location affects the natural resource and population distribution. They will use the information they gained from the virtual tour as well as information from outside websites of their choosing. Then, they will compile all of their groups research into one document by using google docs to create a fact sheet on their region. All of the group members will work on the note sheet at the same time. This will allow the students to collaborate on what information the wish to share with their peers.

Once all of the groups have completed their research they will present their findings to the class. In order to create their presentation, they will then use Google Slides. Google Slides also allows the students to work on the presentation together, like google docs. Once the information from the note sheet has been transferred to Google Slides, the students will present their presentations with their group.

APPENDIX Q3

Lesson Plan of the Research Group from Class C

Subject: Science	
Title of Lesson: Pinterest Project	
Standard: S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter. S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system. S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects. S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves. S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.	
Activity Duration: 2 weeks	**Grade Level**: 8th Grade
Technologies: Pinterest	
Objectives: • Students can use effective research methods while implementing their own unique creativity.	
Meaningfulness of this lesson: • This project allows students to choose their own scientific topic of interest.	

Activity Description
• Students are given the freedom to explore Pinterest with the task of creating a Board that contains 3-5 scientific experiments that they are interested in pursuing. A Pinterest board is a collection of pins (DIY, experiments, articles, etc) that the user chooses. Students will spend some time researching on Pinterest and looking at others' Pins to decide what kinds of things they like and dislike. • Once they have found the required number of possible experiments, the students can choose the topic of their interest and begin working on it. Each student will have a different project, so they will be required to gather their own individual materials. They will perform one of the experiments based on the topic they chose. • Get creative! The student is expected to incorporate their own creativity into whichever project they choose. There are no limitations on this part of the project, as this is completely up to the student's discretion. We want to see the student's individual touches and special aspects to their project! • The student will have plenty of class time to work on this project but will probably have to make some finishing touches on their own time outside of school. They will be able to ask questions or ask for guidance on anything they need help with. • After the duration of 2 weeks, the students are required to present their project to the class. In this presentation the student should explain their initial interest in the chosen topic and what their project consisted of. They should be able to identify their research process and all that it entailed. They will give a personal account of their experience using Pinterest and let us know their opinion whether it was a valuable research tool or not. Their presentation should also incorporate some form of technology (PowerPoint, video, etc.).

APPENDIX Q4

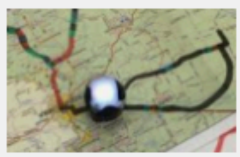
Lesson Plan Design of the Problem-Solving Group from Calss C

Lesson Plan

Subject: Career, Technical, and Agricultural Education
Title of Lesson: Beginning Programming: Intro to Coding
Standard: ELA11W2 The student demonstrates competence in a variety of genres. ELA11W3 The student uses research and technology to support writing. ELA11LSV1 The student participates in student-to-teacher, student-to-st group verbal interactions.

Phase 1
We will show up on the first day with Ozobots. We will lay out the Ozobots and pull up one computer with the blockly website pulled up. We will allow the students to volunteer one at a time to build a code as the whole class watches and give them candy if they do. This is phase one.

Phase 2
Phase 2 will be more individualized and we will put the students in groups with an ozobot each just to have fun with it and try new things. Then, we will test their skills by coding for an ozobot at the front of the room, having the students watch it and work in their groups to try to code their ozobot to copy the one at the front. During this phase, we will incentivize them to really get good at coding by announcing the Ozobot Olympics followed by a raging Ozobot after party at the end of the program.



Phase 3
Phase 3 will come in like a roaring storm. Each student will be given their own ozobot and expected to code for them independently. We will give the students a task, a difficult task. We will lay out a road map (that is ozobot size) and make them find their way through the streets, making strategic stops on their "road trip" and making it to their final destination.

Phase 4
Once the students have had sufficient practice in handling their ozobots and coding their actions, the day will come for the Ozobot Olympics. It will be the most exciting day! Each group will come dressed as their assigned country (or planet) with their ozobot in hand.

Ozobot Olympics

There will be a series of obstacle courses made for this competition. Each course will include multiple checkpoints that the teams' ozobots must pass through (in no particular order) in order to gain points for the competition. The teams will collaborate to choose a specific path that they think is the quickest and most logical. Teams will be given a map of the course and 10 minutes for each round to plan out the most efficient route through the course. Students will have to use design thinking and collaboration to determine the best route for their ozobot. In this 10 minutes, students will have to also use blockly to code their ozobots to take the route that they want. In this portion, students will be able to implement computational thinking to test and develop their code. At the end of the 10 minutes, every team must stop working on their code. Then, a group will be chosen to place their ozobot on the start site and run their code. Points will be given for each checkpoint the ozobot passes through, and if it makes it through all of them, the team that completed the task in the shortest amount of time will be given a bonus. At the end of last round, teams' points will be added up, and one group of students will be crowned the Supreme Ozobot Champions of the World!

APPENDIX R

Participants' Mentimeter Responses toward Digital Literacy Education

*Negative or Neutral responses are in bold.

Classes	Attitudes digital literacy education
A and B (36)	- **Our world has changed now and technology is evolving very quickly so we rely on technology a lot. However, it is still true that the basics of Math and Reading can get you the same knowledge.** - **Although using the technology helps us to achieve what we want but that doesn't mean it's not possible to do what we want without the technology. Technology just aids us to get there faster.** - **I would love to think that people can still do big things without relying on technology. I do not like to think that this day and age has become so dependent on technology that a person is unable to accomplish their goals without it.** - Times change and educators are expected to evolve with advanced technologies. - I agree, mastering the basics will help you project your career, but mastering the technology will boost your career so much more. - That is true, there are very smart people in successful careers that were only brought up with reading, writing, and arithmetic. But, with technology today people have access to so many opportunities that the next generation will be even smarter. - It is not impossible for people to be successful without the aid of technology. However, there is no reason to reject the use of technology when it can clearly assist people in many ways making it more convenient to learn or do stuff. - Although this is true, the world is different now and technology is very relevant today. With technology we can promote even more learning and advance even more. - I think that it is possible for people to be successful without the usage of technology; however, I think it is more beneficial if they incorporate technology into teaching children, since everything is so technology based in today's society. - I think that students need to understand how to use technology and understand digital citizenship because of the day and age they live in. Now, most things are run by technology while 20 or so years ago, that was not really the case. - K-12 students should definitely learn digital literacy. This will help insure their Web safety and confidence. Teaching them while they are young will create a safer more efficient life online. -Students need to learn how to use technology because that is the future of society. If we want innovative thinkers and responsible digital citizenship in the next generation, it is important to use technology as a tool and supplement in the classroom

	- They should learn how to do all of these things and establish some level of digital literacy. Understanding these seven concepts will allow them to have a more fulfilling educational process for them and their peers. - I agree it is possible to be successful without technology, but it makes it much more difficult, Technology was created to make it easier for use to learn and be successful. - Yes, there are many people today that were only brought up with only the basics. However, in order to keep up with everyone else they will need to learn how to incorporate technology into their life and their workplace. -Technology should never replace the teacher, rather it should be used to enhance the students learning experience. Students need to use more technology in the classroom since society as a whole is becoming more dependent on it. -It is important for K-12 students to be digitally literate because times are changing, and everyone is learning to have adequate digital citizenship. Becoming digitally literate does not make modern doctors any less valid than past doctors. -Times are now developing, where these professions need to use technology. The importance of using new technology is to perform their job at a high standard. - I think they most doctors, lawyers, and business professionals were brought up without much technology development to help them evolve educationally, but today we use technology along with basic curriculum to help grow educationally. -There are many smart professionals in this world who are capable of accomplishing many things without the help of technology because they were brought up without it, but presently technology has taken over and need it to be successful in our society. - The future is technology, so it is prudent that students adapt to the changing and advancing world of education. - It would be very beneficial for K-12 students to learn how to communicate, collaborate, create, publish, research, and solve problems with technologies as well as establish adequate digital citizenship. Technology helps students better themselves. - Students need to learn so that they can interact correctly with other users. Also, they also need to understand how to safely use the internet. - Yes, they do due to the fact that in college being familiar with the various forms of technology is important. A lot of lectures, textbooks, clicker questions, attendance, etc is used through technology so it is definitely important - That makes sense that they were able to make it to their position without the aid of technology but to be brought up in today's technological age it would be exponentially more difficult to not manipulate technology as you pursue your career path. - Although this statement is true, it applies to people of a different generation. It is still very important to teach reading, writing, and arithmetic, but in today's society, it is imperative that people learn how to use technology. - I believe there is a huge opportunity to advance education through the use of technology. The information of past scholars can be better understood through using technology.

	- Technology has been increasingly integrated into everything we do, no matter what field your work is in. Although that did not used to be the case, these days it is necessary to know how to utilize technology and practice digital literacy effectively - Technology can aid us with an abundance of crystalized intelligence by gathering and collecting information. But it can not create fluid intelligence, as its utility function does not go beyond the human intelligence that created it. - Yes, people can thrive without technology, but as Shuri from Black Panther says, "just because something works doesn't mean it can't be improved." There can always be an easier, effective, and more engaging way to learn. - Digital education is important as advancements are made regardless of how you could've been successful without them. In an ever-changing world, students need to be prepared through technology education. - I agree that students need to learn how to interact with others online by learning crucial privacy aspects. - Yes. The skills learned using the technology will be useful in the real world because the real world and digital world are so connected. Being digitally literate is vital. - I think that this quote shows how people were able to accomplish great things with minimal technology. But it shouldn't undermine the importance of using technology in the present. - They definitely need to learn to communicate and collaborate through technology because it is so important and vital to the professional world they will be entering in the future. Also, digital literacy is important to know because it will be used.
C (8)	**- I think that students can do without learning with technology. This is primarily because I know many people who are successful without this knowledge. However, we live in a time when utilizing these tools would be helpful, but it's not necessary.** - While learning the basic skills without technology is important for student development, there is increasing need for students to understand how to use technology and different skill sets in order to be successful in digital collaboration & response - Even though it is definitely possible to grow up to be successful and smart without the aid of technology, technology makes it much easier and more fun for students to learn through interaction. - Apart from that, having the ability to visualize concepts and create using media helps express the student's thoughts and generate a digital space for productivity and collaboration in and out of the classroom. - The world is shifting to a place where it's vital for students to know how to use technology to enhance the skills to achieve in their professional lives. Students can be taught how to use tech resources and use them responsibly to further themselves - I think that these students do need to learn these areas. With the advancing world of technology, if nothing else it will only prepare them for their future endeavors. Also, digital citizenship will be beneficial to them.

	- Students do need to start learning communicate, cooperate, and etc and establish adequate citizenship. Technology is a huge part of our everyday lives including the classroom, and it is only going to become more complex from here. - K-12 students do need to learn how to communicate, create, and solve problems with technologies, as well as be adequate online citizens, because those skills are needed in the world today. Learning these skills can save students the trouble later.

APPENDIX S

Learning More about Digital Literacies from the Post-survey

Class A
- I think it is very important because it is beneficial to know how to communicate digitally in our day and age. - Positive because it will help me - Very high because it shapes society in the 21st century - For the purposes of doing well in this class, my motivation toward learning more about digital literacy is very high. - I am interested in learning more about digital literacy. - I've learned a lot through this project but would be interested in learning more before I graduate. - I am very motivated to learn more. - I try to learn more diverse skills such as making more professional video. - I like learning about it! Still want to know more. - I would say I am quite motivated to learn more about digital literacy because sometimes I feel like others know more about digital literacy compared to me. Therefore, I am motivated to learn more and expand my knowledge - It's important, but there can be such a thing as too much technology. - From the beginning of the year to now, I am more confident with my digital literacy skills. - I am currently motivated to learn more about digital citizenship because it plays a large role in your life as you begin to search for a career. - New digital technology inspire me to learn new things
Classes B and C
- I want to understand more advanced programming in the future. This class has encouraged me to want to learn more about this. - This project motivated me to learn a lot about tech. - I believe I have learned so much about digital literacy throughout the past couple of weeks and I am excited to learn more. - My motivation is big for learning more about how to use technology. - I am very motivated because of this class I have learned about new sites as resources that I've never heard of. - I want to learn more because it is an alternative to using book. - Very motivated, before this class I knew very little about tech. Now I can't wait to learn more. - I am very motivated about learning more about digital literacy. It is a very important thing to understand. - I learn a lot of new tools and skills that I'm excited to learn more! - I would say I'm moderately motivated because I think it's important and interesting. I've learned a lot so far and I have enjoyed it.

- I think it's a great idea and more people should know about it. - I am very motivated due to the fact that this knowledge will help me as a student and a future educator. - I am pretty motivated. I think that it will be able to enhance my students' education therefore I really want to learn it. - Very motivated. In the current world we live in, it is more and more important to be digitally literate in order to be successful. - As technologies advance, I have no choice but to understand the complexities they hold. - I want to continue to learn and grow in this area. I also learned so many technologies I wouldn't know otherwise. - I wish to learn more so that I may be informed better in using technology. - I am somewhat motivated toward learning more about digital literacy, but I believe I already have many skills about digital literacy. - I am really enjoying learning more about digital literacy. - I want to understand more advanced programming in the future. This class has encouraged me to want to learn more about this. - I am highly motivated toward learning more about digital literacy. - I think that digital literacy is only getting more relevant, so I think it is important to keep learning. - As I begin looking for employment beyond school, I am realizing the importance of having digital literacy and knowledge. - I am highly motivated as I see this as very important to the learning process. - I would love to learn as much about it as possible, it's very important. - I think digital literacy is very important in the future education where student utilize the technology to the full extent in order to gain knowledge.

APPENDIX T

IRB Approval Letter

UNIVERSITY OF GEORGIA

Tucker Hall, Room 212
310 E. Campus Rd.
Athens, Georgia 30602
TEL 706-542-3199 | FAX 706-542-5638
IRB@uga.edu
http://research.uga.edu/hso/irb/

Office of Research
Institutional Review Board

EXEMPT DETERMINATION

September 7, 2017

Dear Janette Hill:

On 9/7/2017, the IRB reviewed the following submission:

Type of Review:	Modification: • Added incentive • Revised recruitment and consent materials
Title of Study:	Enhancing Preservice Teachers' Digital Literacies in CSCL
Investigator:	Janette Hill
Co-Investigator:	Jeonghun Oh
IRB ID:	MOD00005023
Funding:	None
Review Category	Exempt 2

The IRB approved the protocol from 9/7/2017 to 8/13/2022.

Please close this study when it is complete.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103).

Sincerely,

Kate Pavich, IRB Analyst
Human Subjects Office, University of Georgia

APPENDIX U

IRB Consent Form

UNIVERSITY OF GEORGIA
CONSENT FORM

Digital Literacies in CSCL Environments

Researcher's Statement

We are asking you to participate in a research study. The purpose of this study is to develop guidelines for creating an EDIT 2000 course to enhance preservice teachers' digital literacies and collaborative interaction in Computer Supported Collaborative Learning (CSCL) environments. Please take the time to read the following information about the research study. Please do not hesitate to ask the researchers if you need further information. When everything is clear to you, you can decide if you want to participate in this study or not. This process is called "informed consent." A copy of this form will be given to you.

Principal Investigator: Dr. Janette R. Hill
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Phone: (706) 254-1157
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Co-investigator: Jeonghun Oh
Career and Information Studies, College of Education
Phone: (706) 248-7393
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Purpose of the Study

The purpose of this study is to explore aspects of preservice teachers' digital literacies and collaborative interaction based on activities and projects completed in EDIT 2000. The current research will be the first iteration of design based research. The purpose of this study is to develop guidelines for creating an EDIT 2000 course to enhance preservice teachers' digital literacies and collaborative interaction in CSCL environments.

Study Procedures
If you volunteer to participate in this research study, the following things will happen:

- You will be asked to respond to two surveys (approx. 15 minutes each), one at the beginning and one at the end;
- You will be invited for a 20-30 minute interview (face-to-face, phone, Skype, or Google Hangouts) related to your experiences in EDIT 2000. The interview will be audio recorded;
- Researchers will observe class activities and make observation notes.
- Your performance data based on activities and products created in EDIT 2000 will be collected.

Compensation
To the research participants, compensation for participation will be offered. To the students who participate in the research will be offered a last pass. A late pass can be used to submit an assignment up to 24 hours after the due date with no penalty, excuse an absence, and receive an extra point (0.1 point). To the students who are invited to the interview, a free pass will be offered. A free pass can be used to excuse an absence.

To the non-participant students, an equal opportunity to earn a late pass and a free pass will be offered. If non-participant students submit one page of ideas about fun and meaningful activities which can be applied to EDIT 2000 courses, they will earn a late pass. If non-participant students submit two pages of constructive feedback regarding the current EDIT 2000 course, they will receive a free pass to excuse an absence.

Risks and discomforts
We do not anticipate any risks from participating in this research; however, it is possible that you may feel some anxiety when asked questions about your opinions about activities in EDIT 2000.

Benefits
This research has the potential to improve practices of EDIT 2000 courses to enhance preservice teachers' digital literacies and collaborative interaction. The surveys and interview may help you better understand your own learning needs such as digital literacies needed for teachers and effective collaborative activities.

Alternatives
As an alternative, those who choose not to participate in the study will read two short articles about technology integration into education while the participants fill out the pre-survey and post survey.

Privacy/Confidentiality
Any identifiable results of the study will not be released to anyone other than researchers working on this study without your written consent unless required by law. Your identity will be protected without making any association with any information in any published format.
If you volunteer to take part in this research, it is necessary for you to write your name and UGA email when you complete the surveys. The reason we are asking you to do so is that the survey data is needed to be linked to other data sources such as collaborative activities and your interview for the purpose of analysis. We will replace UGA email or your name on all data sources with a pseudonym that only researchers can identify. The key to the pseudonym will be password protected in the electronic file. The electronic file of the code key will be kept separately from the research data. 3 years after completing data analysis, the research data such as the audio recording of the interviews, survey data and the electronic file of code will be destroyed. This research involves the transmission of data over the Internet while you complete online surveys or during interviews using Skype or Google Hangouts. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

Taking part is voluntary
Taking part in this research study is voluntary, and if you decide to participate, you can withdraw anytime without any penalty or loss of benefits to which you are otherwise entitled. If you decide to stop participating in the study, the information and data collected from you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed. However, if you make a written request to remove or destroy the information and data, your information and data will be removed or destroyed and will not be analyzed any more. Your decision about participation will not affect your grades or class standing.

If you have questions
The main researcher conducting this study is Jeonghun Oh, a doctoral student at the University of Georgia. Please feel free to ask any questions you have now. If you have questions later, you may contact Jeonghun Oh at jo85630@uga.edu or at (706) 248-7393. If you have any questions or concerns regarding your rights as a research participant in this study, you may contact the Institutional Review Board (IRB) Chairperson at (706) 542-3199 or irb@uga.edu.

Consent to Participate in Research
To voluntarily agree to take part in this study, you must sign on the line below. Your signature below indicates that you have read or had read to you this entire consent form and have had all of your questions answered.

___________________________	_________________________	__________
Name of Researcher	Signature	Date
___________________________	_________________________	___________
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher.