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Digital Literacy Development in Teacher Education: A Case Study

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Digital Literacy Development in Teacher Education: A Case Study

by

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Abstract

With increasing technological advancement, developing citizens' digital literacy is more crucial than ever before in supporting Canada's societal and economic future. Teachers hold a critical role in fostering their students' digital literacy development.

Using case study methodology, the objective of this research was to gain a deeper understanding from the perspectives of an administrator and five instructors on how pre-service teachers understand and develop digital literacy with the central research question of: How is digital literacy developed within a Design-based Thinking course in a teacher education program? The research question was investigated through collecting data on opportunities in one teacher education program for pre-service teachers in developing digital literacy in a Design-based Thinking course. Data were collected using individual interviews, focus group interviews, and document analysis. The collected data were analyzed through thematic analysis and two cycles of coding to identify emergent themes of participants' understanding and perceptions of digital literacy development within the context of the Design-based Thinking course within the teacher education program.

Four key findings emerged from this research study. First, instructors' openness (or risk-taking) and modeling the usage of digital technologies in courses within the teacher education program encourage pre-service teachers to use digital technologies. Second, opportunities for feedback in support of pre-service teachers' digital literacy development can be provided through learning tasks and assessments. Third, teacher education programs need to consider establishing program goals focused on developing digital literacy and provide professional development opportunities to support instructors' in designing and facilitating pre-service teachers' digital literacy development. Fourth, instructors need to have an understanding of digital literacy to

design authentic and embedded learning tasks for pre-service teachers focused on supporting

digital literacy development.

Preface

This thesis is an original, unpublished, and independent work by the author, Kristi-Mari Fedorko-Bartos. The University of Calgary Conjoint Faculties Research Ethics Board (CFREB) provided approval for the study on December 15, 2020 under the Ethics Certificate number REB20-1743.

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Dedication

To my mother, my role model.

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CHAPTER ONE: INTRODUCTION

Digital technologies continue to impact every part of daily life, including economic, political, and socio-cultural levels for local, national, and international sustainability and prosperity (Blum-Ross et al., 2020). During the COVID-19 pandemic, digital technology usage has grown (Vargo et al., 2021). From social communications to financial transactions, our ability to make personal and professional connections is increasingly dependent on our *digital literacy*. Digital literacy is the use of digital technology to communicate, comprehend, and critique digital texts and content with responsible digital citizenship to creatively problem-solve as a consumer and creator of knowledge (Belshaw, 2011; Martin & Grudziecki, 2006; Ng, 2012). Industries such as manufacturing, retail, healthcare, finance, and transportation are requiring employees to have digital literacy skills (Anani, 2018; Statistics Canada, 2018). Fifty-five percent of adults in Canada have basic digital literacy skills such as web browsing or email use (OECD, 2016). More than ever, being digitally literate is crucial in shaping Canada's social and economic future.

Teachers are key in supporting the development of youth's digital literacy to position students well to address complex demands of a global, technological future. Today's teaching and learning landscape increasingly requires teachers' digital literacy development (Daniels et al., 2020). Teacher education or teacher preparation programs are starting to respond to the greater need for digital literacy, but deeper understanding is needed to comprehend its nature and ways for pre-service teachers to develop it (List et al., 2020).

I completed a teacher education program and experienced the growing emphasis of digital literacy. Throughout my collective experiences, I recognized the importance of developing teachers' digital literacy to equip their students for their future. I designed this thesis

to gain a deeper understanding of how digital literacy is developed in a teacher education program within a Design-based Thinking course.

Statement of the Problem

With digital literacy, as noted by Blum-Ross et al. (2020), "there is an urgent need for every citizen to develop the knowledge, skills and attitudes required to participate in a complex and increasingly digitised society for personal and societal prosperity" (p. 3). Youth today are growing up in a society where digital literacy holds an growing critical role in home, school, and work. Teachers are pivotal in the development of students' digital literacy; greater effort is being placed into strengthening pre-service teachers' digital literacy in teacher education programs (Spante et al., 2018). Despite recent efforts, there is an evident gap between pre-service teachers' technical and pedagogical skills in classrooms, as well as pre-service teachers and teacher educators' overall digital literacy (Gudmundsdottir & Hatlevik, 2018; Røkenes & Krumsvik, 2014; Tondeur et al., 2017; Valtonen et al., 2015).

From my review of the literature, more research is needed on how in teacher education programs digital literacy is developed and/or fostered with pre-service teachers. The central purpose of my study was to explore how pre-service teachers' digital literacy is understood and developed within teacher education programs when students are engaged in a Design-based Thinking course. The work was guided by the following research question: How do pre-service teachers develop digital literacy within a Design-based Thinking course in a teacher education program? I selected a Design-based Thinking course given all pre-service teachers in this teacher education program are required to complete it in their final semester.

Context of the Study

The twenty-first century digital paradigm is one of the most expansive influences on our lives (Hewitt, 2016). The Government of Canada in particular recognizes that "effective participation in the labour market is increasingly linked to digital competence" (Government of Canada, 2014, para. 4). In an effort to use digital technology to improve the lives of its citizens, the Government of Canada has implemented federal initiatives including the Digital Canada 150 Plan (Government of Canada, 2015).

As technological progress and innovation is propagating a robust change in the labour market, the Government of Canada has composed an Innovation and Skills Plan (Government of Canada, 2017) that contains support for teaching of digital literacy and skills for Canadians of every age, background, education, and employment opportunity in the growing digital economy (Government of Canada, 2019). Through such an initiative, the Canadian Government is committed to equipping Canadians with the digital tools and literacy development required for long-term prosperity, innovation, and industrial and economic growth (Government of Canada, 2015).

These efforts recognize the growing importance of digital literacy for Canadians in the present and future economy; critical attention must be given to improve a continuing "lag" in promoting digital literacy (Brookfield Institute, 2017). Teachers' own digital literacy development is likewise ever more important, as they have influence in teaching current and future citizens (List et al., 2020; Spante et al. 2018).

Study Rationale and Significance

Digital technologies are a growing reality in all aspects of our lives, and, with government initiatives, teacher education programs are making efforts to develop pre-service teachers' digital literacy (Government of Canada 2017; List et al., 2020). Researching this phenomenon is important, for pre-service teachers are preparing students for their futures, which includes the inevitability of living and working digitally (Brookfield institute, 2017; McGarr & McDonagh, 2019; Rizal et al., 2019). Accordingly, the purpose of my study was to investigate the development of pre-service teachers' digital literacy within a Design-based Thinking course in a teacher education program.

Assumptions

There are two assumptions on which this study was based. The first was the assumption that digital literacy is an important literacy to be developed with pre-service teachers. A second assumption was that teacher education programs have a role in preparing pre-service teachers in teaching digital literacy. These assumptions informed my choice of theoretical framework (discussed in Chapter Two) and research design (discussed in Chapter Three).

Definition of Key Terms

For the purpose of my study, I adopted the following terms and definitions:

Design Thinking: A "mindset and approach to learning, collaboration and problem solving… for identifying challenges, gathering information, generating potential solutions, refining ideas, and testing solutions" (Teaching and Learning Lab, 2020, para. 1).

Digital Literacy: Using digital technology to communicate, comprehend, and critique digital texts and content with responsible digital citizenship to creatively problem-solve as a consumer and creator of knowledge (Belshaw, 2011; Martin & Grudziecki, 2006; Ng, 2012).

Instructor: Academic staff, including a faculty member or sessional instructor who teaches a course in a teacher education program.

Pre-service Teacher: A student who is currently enrolled in a teacher education program.

Chapter Summary

In this first chapter, I presented the problem, context, rationale, significance, and assumptions for my study. In Chapter Two, I present a review of the literature focused on digital literacy, and design thinking. I conclude the chapter by positioning my study with the chosen theoretical framework of social constructivism. In Chapter Three, I discuss the research design, including with methodology and data collection and analysis methods. The chapter concludes with boundaries, limitations and delimitations, ethical considerations, and researcher role and background. Chapter Four, I present and discuss the findings of the study including participants' demographic information and a thematic analysis of the collected data. In Chapter Five, I discuss the analyzed data and conclude the chapter with the presentation of a conceptual framework for developing pre-service teachers' digital literacy. In Chapter Six, I identify and discuss implications for practice and recommendations for future research.

CHAPTER TWO: LITERATURE REVIEW

The focus of this chapter is my review of the literature on digital literacy, and design thinking in the context of education and teacher education programs as the research pertains to my study. In conducting my literature review, I used search terms such as *digital literacy* or *digital competence* or *digital skills*. In the review portion for design thinking, I used search terms such as *design thinking* or *design thinking process* or *design thinking in education*. For both portions of the review search terms such as *education* or *school* or *teaching and learning* and *teacher education* or *teacher preparation* or *pre-service teaching* were used. I searched the following databases: Academic Search Complete, the Education Resource Information Center (ERIC), Education Research Complete, and Google Scholar.

The literature review is structured based on the following five topics: 1) defining digital literacy and examining characteristics, 2) digital literacy in education and teacher education programs, 3) design thinking, and 4) theoretical framework. The chapter concludes with the positioning of the study within the body of research.

Digital Literacy

Defining Digital Literacy Through its Characteristics

The definition of digital literacy is entwined with its underlying characteristics (Bawden, 2008; Ng, 2012). From a historical context, it is useful to first understand its relative origins in the word *technology*. Etymologically, as defined in *The New Encyclopædia Britannica,* the word technology means *the art of the word* as it is a compound of the Greek word *techne*, meaning art craft, and *logos*, or word, speech (Encyclopædia Britannica, 1993, p. 440). By the early twentieth century, the meaning of the term (technology) grew to include a wider range of processes, tools, and machines such as digital technologies and computers (The History of Technology, 1993).

"Digital technologies refer to a subset of electronic technologies that include hardware and software used by individuals for educational, social, and/or entertainment purposes in schools and at home" (Ng, 2012, p. 33). Ng (2012) provided examples of digital technologies that include technologies such as desktop computers, interactive white boards, mobile devices, software, and apps. All of these digital technologies are important tools for teaching, learning, and daily living (Jonassen, 2008; Stewart & Hedberg, 2011). Digital technologies used within daily life increasingly depend on digital literacy.

When discussing digital literacy, the term digital competence is often referenced (Yazon et al., 2019). The extent to which these two terms are synonymous is under debate and there is no agreed upon definition for digital literacy due to its novel and evolving nature (McGarr & McDonagh, 2019). Digital literacy may indicate linguistic translations between countries and/or reflect the challenges for a ubiquitous definition amidst its diverse and ever-changing characteristics over time (Erstad, 2015; Kotlay, 2011; McGarr & McDonagh, 2019). Spante et al.'s (2018) systematic review of digital literacy and digital competence in higher education indicated that despite the term *competence* being used more frequently since 2010 (and specifically in Europe), the term *literacy* remains the dominant term (especially in North America). Other scholars (i.e., Ilomaki et al., 2016; Siddiq et al., 2016) have noted that digital literacy is most often used interchangeably with digital competence, whereby within a single article both terms may be used. For consistency in this study, I used the term digital literacy even though some references may use the term digital competence.

From my review of the literature, it is evident that the understandings of digital literacy are broad, and terms are not used consistently (Bawden, 2001; 2008). Digital literacy builds upon the earlier concepts of information literacy and computer literacy (Bawden & Robinson, 2015).

However, various literacy terms (e.g., media literacy, Information Communication Technology (ICT) literacy) are used and understood interchangeably and inequivalently in the literature in reference to digital literacy (Bawden & Robinson, 2015). To gain better understanding of how digital literacy as a concept is situated in the literature, I provide here a brief overview of computer literacy and information literacy.

In the early 1980s, computer literacy was often called Information Technology (IT) or ICT literacy and refers to the "skills and knowledge needed to use IT systems effectively" (Bawden & Robinson, 2015). However, computer and ICT literacy do not include other skills such as those involving the evaluation of information and organization, which is inherently limiting (Bawden & Robinson, 2015). While related to computer literacy, information literacy extends the notion of computer literacy to enable evaluation and effective use of information in a specific context.

In the later 1980s, information literacy was used widely in library and information circles, with a preliminary definition by the American Library Association (1989) as being able to identify, find, evaluate, and use information effectively for a given context. Information literacy extends the processes of computer literacy, because the processes of information literacy adds the dimensional steps of critically thinking about information through aspects such as evaluation and organization (American Library Association, 1989; Bawden & Robinson, 2015).

Digital Literacy

Digital literacy as a term was introduced in the 1990s by Gilster (1997) as "the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers" (p. 1). Bevan (2017) elaborated upon Gilster's (1997) definition to be

"literacy in the digital age," where the traditional notion of literacy is the ability of reading, writing, and dealing with information "using the technologies and formats of the time" (Bawden, 2008, p. 4). Bawden (2008) referred to this as the present form of the traditional notion of literacy (i.e., the ability to read and write) in the digital age.

Gilster (1997) did not specifically indicate sets of skills, competencies, or attitudes associated with digital literacy. Bawden (2008) noted that Gilster's (1997) definitional approach can be viewed as quite loose for concrete interpretation, and yet at the same time it can provide an "unrestrictive" account of digital literacy for relevant applications over time. According to Bawden (2008), the key focus of Gilster's (1997) conceptualization of digital literacy is that it is about mastering ideas rather than keystrokes, which contrasts "restrictive competence lists" and skills seen in information literacy (Bawden & Robinson, 2015). Martin and Grudziecki (2006) stated that Gilster (1997) did emphasize characteristics such as critical thinking, which opens up the concept of digital literacy to beyond a limited, sole focus on technical skills (i.e., operating a web browser).

Gilster's broad approach to digital literacy has been influential as a base for subsequent definitions. For example, the DigEuLit project formulated the following digital literacy definition for their work:

> Digital Literacy is the awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesise digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process. (Martin & Grudziecki, 2006, p. 255)

While originally based on Gilster's (1997) definition, the Martin and Grudziecki's (2006) definition of digital literacy elicits a more rounded description that identifies specific processes of digital literacy such as analysis, creation, and communication.

The *British Futurelab Handbook on Digital Literacy Across the Curriculum* by Hague and Payton (2010), provided this definition:

> To be digitally literate is to have access to a broad range of practices and cultural resources that you are able to apply to digital tools. It is the ability to make and share meaning in different modes and formats; to create, collaborate and communicate effectively; and to understand how and when digital technologies can best be used to support these processes. (p. 2)

Eshet-Alkalai (2004) elaborated on the processes of digital literacy by including its technical, cognitive, and sociological characteristics. Eshet-Alkalai (2004) suggested that digital literacy is comprised of the integration of five types of literacies: photo-visual literacy, reproduction literacy, branching literacy, information literacy, and socio-emotional literacy. According to Eshet-Alkalai (2004), photo-visual literacy is the understanding of visual representations; reproduction literacy is the creative re-use of existing materials. Information literacy is primarily understood as the evaluation of information, while branching literacy is the ability to read and understand hypermedia. Lastly, social-emotional literacy means behaving appropriately and safely online (Eshet-Alkalai, 2004; Bawden, 2008). As seen from Eshet-Alkalai's (2004) interpretation of digital literacy, it is understood that digital literacy can be conceptualized from a plurality of literacies.

Digital literacy "is composed of different literacies" (Kotlay, 2011, p. 216). Kotlay (2011) asserted that the all-encompassing nature of digital literacy lends itself to being thought of as composed of different literacies: media literacy and information literacy. According to Kotlay (2011), information literacy emphasizes critical thinking, meta-cognition, and procedural knowledge for locating information in specific domains and contexts. An information-fluent individual is able to identify credible and authentic digital content (Kotlay, 2011). Media literacy refers to analytic characteristics and shares commonalities with information literacy in this respect (Kotlay, 2011). While Kotlay (2011) pointed out the multi-literate nature of digital literacy, his selection of literacies central to digital literacy is relatively fewer and summarized into differently understood categories when compared with the comprising literacies of Eshet-Alkalai (2004).

My review of the literature indicates two approaches to defining digital literacy. First, the broader approach presents a general overview of digital literacy when compared with more specific definitional understandings (Gilster, 1997). Second, the specific approach facilitates concrete understandings and operational applications (Bawden, 2008; Martin & Grudziecki, 2006).

To gain contrasting understanding of digital literacy, Ng (2012) focused on analyzing the characteristics of digital literacy definitions in developing a comprehensive definition:

The basic skills that a digitally literate person should be able to demonstrate are:

- carry out basic computer-based operations and access resources for everyday use
- search, locate, and assess information effectively for both purposes of research and content learning where assessing information involves the ability to critique through the analysis and evaluation of digital content for authenticity

- select and develop competency in using the most appropriate technological tool or features to complete a task, solve problems, or create products that best demonstrate new understandings

- behave appropriately and communicate effectively in social network communities and protect oneself from harm in digitally enhanced environments. (Ng, 2012, p. 53).

Ng (2012) acknowledged the technical, cognitive, and social characteristics of digital literacy, while bringing to our attention the importance of thinking critically and acting responsibly in managing information in a social network.

Belshaw (2011) used a similar approach to Ng (2012) in primarily focusing on understanding digital literacy as an assortment of characteristics. Belshaw's (2011) interpretation has allowed for the elements of multiple definitions to be consolidated into the key central elements of which digital literacy is composed. Belshaw (2011) outlined the following eight essential characteristics of digital literacy (referred to as digital "literacies" by Belshaw (2011): cultural, cognitive, constructive, communicative, confident, creative, critical, and civic. Flexibility is employed in this approach, as elaborations on each characteristic are available for succinct explanation. For example, Belshaw (2011) explained that the communicative element is about "understanding how communications media work" and "in essence, the nuts and bolts of how to communicate in digital networked environments (p. 209). Belshaw's (2011) eight essential characteristics of digital literacy are expanded upon concisely, and it seems to me that he presented the benefits of both a more broad and specific approach to digital literacy.

Given my review of the literature, I have combined characteristics of digital literacy definitions and understandings to create the following operational definition used for this study: Digital literacy involves using digital technology to communicate, comprehend, and critique

digital texts and content with responsible digital citizenship to creatively problem-solve as a consumer and creator of knowledge (Belshaw, 2011; Martin & Grudziecki, 2006; Ng, 2012).

All of the definitions used to create this definition of digital literacy all contain overlapping characteristics and were chosen for specific reasons. The Ng (2012) definition is incorporated for descriptive qualities and specific inclusion of citizenship in utilizing digital technologies. The Belshaw (2011) definition was selected as it is appreciated for its alliterative qualities that facilitate quick recall. Martin and Grudziecki's (2006) definition provided the element of being a constructor, or a creator of new knowledge.

Digital Literacy in Education and Teacher Education Programs

According to von Hohenberg and Broderick (2021), a teacher education (or teacher preparation) program is an educational training program located usually at universities, where students learn the required skills for teaching in K–12 schools. Teacher education programs are designed to prepare undergraduate students, who are pre-service teachers, to become certified teachers and offer a variety of grade level and subject specializations for those enrolled in the program (Blankenship, 2020). In addition to specialization courses, teacher education programs design, adapt, and offer a number of course offerings based on teaching methods and approaches deemed important for pre-service teacher training (Stuart & Tatto, 2000).

Digital Literacy in Education

For students to be digitally literate, K–12 schools are heightening ways in which to infuse digital technology and literacy practices in a way that is purposeful and meaningful (Brookfield Institute, 2018; Jonassen, 2008). On a provincial level, Alberta Government (2013) developed a *Learning and Technology Policy Framework* to support K-12 school boards, administrators, and teachers in developing policies to help achieve effective practices for teaching and learning with

digital technologies for students. Therein, technology is recognized as having an important role in education and needed to "support the creation and sharing of knowledge" (Alberta Government, 2013, p. 9). The *Learning and Technology Policy Framework* is centered around five policy directions for teachers, administrators, and educational professionals:

1) Student-Centred Learning;

2) Research and Innovation;

3) Professional Learning;

4) Leadership; and

5) Access, Infrastructure and Digital Learning Environments. (Alberta Government, 2013, p. 9).

The first policy direction refers to the usage of technology to support learning that is personalized, focused, and authentic for students. The second policy direction discusses how teachers and administrators should read, share, and apply innovative research and evidence-based practises in education. The third policy direction brings to attention the importance of professional learning to develop and apply the knowledge and skills necessary for using technology effectively and innovatively to support teaching and learning. The fourth policy direction is centered on education leaders establishing the structures and building capacity within their systems to use technology for supporting student learning. The fifth policy direction revolves around students, teachers, administrators, and educational professionals having appropriate access to devices, and dependable infrastructure with high-speed networks for digital learning environments (Alberta Government, 2013). For each policy direction, "a rationale/ research base, associated outcomes and recommended actions for the provincial government and school authorities" is outlined (Alberta Government, 2013, p. 17).

The Information and Communication Technology (ICT) K-12 curriculum by Alberta Learning (2016) is a provincial document designed to provide a "broad perspective on the nature of technology, how to use and apply a variety of technologies, and the impact of ICT on self and society" (p. 1). The ICT Program of Study is intended to be infused within core subject areas (i.e., mathematics, language, arts, science, social studies), rather than reside as a separate subject (Alberta Learning, 2016). Alberta Learning (2016) outlined both general and specific outcomes, as well as illustrative examples and an assessment framework for K-12 teachers to use for students in their core subject areas. Outcomes are organized into the following categories:

1) Communicating, Inquiring, Decision Making and Problem Solving;

2) Foundational Operations, Knowledge and Concepts; and

3) Processes for Productivity. (Alberta Learning, 2016, p. 4).

The first outcome category concerns students' ability to assess information critically, solve problems, research, and communicate in authentic situations. The second outcome category refers to understanding how to use technology, (i.e., media, multimedia technology) and its moral and ethical usage in a digital context. The third outcome category is associated with the skills and knowledge for productivity techniques and tools (i.e., data organization; graphics and audio for multimedia creation and editing; digital communication and collaboration) (Alberta Learning, 2016). The ICT curriculum is focused on Albertan teachers and students best learning about and with technologies within real-life contexts (Alberta Learning, 2016).

From school jurisdictions investing in up-to-date digital technologies, and incorporating digital literacy practices into curriculum, it is teachers and their digital literacy that plays an important role in teaching students, which is why digital literacy development is receiving attention in teacher education programs (Brookfield Institute, 2017, 2018; List et al., 2020; Spante et al., 2018).

Digital Literacy in Teacher Education Programs

Teacher education programs are increasingly placing efforts towards pre-service teachers' digital literacy development. For example, Røkenes and Krumsvik (2014) conducted a review on the digital competence development of pre-service teachers in teacher education programs for the secondary school grade level. Their work identified eight approaches that were used by teacher education programs for developing pre-service teachers' digital competence: collaboration, metacognition, blending, modeling, authentic learning, student-active learning, assessment, and bridging the theory/practice gap. An important finding of their study was that teacher education programs are improving pre-service teachers' access to technology and that increasing their confidence is not enough to support meaningful teaching with digital technology. Similarly, a review by Hauck and Kurek (2017) on digital literacy in teacher preparation found that several components such as efficient teacher training and instructor modeling are effective in developing pre-service teachers' digital literacy. Hauck and Kurek (2017) pointed out that student teachers (pre-service teachers) can have limited opportunity to develop digital literacy through instructor modelling since few instructors are familiar with creating technology-rich learning environments where technology is viewed as more than just a research tool.

McGarr and McDonagh (2019) conducted a review surveying the existing literature on digital competence in teacher education to analyze how it is being implemented and understood. Their investigation revealed the need for more research on digital literacy in teacher education. Specifically, they argued that greater attention be given to exploring the lived experiences of pre-service teachers' acquisition of digital competence (early on in their education program) to inform their own learning and pedagogy. Further, McGarr and McDonagh (2019) identified hierarchal and developmental models that can be used to understand pre-service teachers' digital competence. A taxonomy-type model involves identifying various dimensions of digital literacy that may not necessarily be related, while a hierarchical-type model is developmentally based with related levels of competence (McGarr & McDonagh, 2019). The hierarchal and developmental model for understanding digital literacy development can support the scaffolding of digital literacy development (McGarr & McDonagh, 2019). Curriculum reviews that consider the mapping of courses and their scaffolded progression support the development of skills and competencies. (Kaupp & Frank, 2014; Lock et al., 2018).

Through survey data collection methods, List (2019) sought to examine pre-service teachers' conceptions of digital literacy development in their early teacher education years (i.e., first-year students and sophomore). The majority of pre-service participants (84 percent) reported developing digital literacy through formal rather than informal contexts (i.e., structured K–12 school and classroom contexts). Analysis of the data revealed that pre-service teachers hold "at least three conceptions of how digital literacy may develop" (p. 156), which is consistent with the literature: digital natives, skill-based, and sociocultural approaches to digital literacy development.

The pre-service teacher participants acknowledged that digital literacy is a developmental process. List's (2019) study provides insights on pre-service teachers' perspectives on digital literacy development, which are indicated as autonomously developed, technology driven, or project based. Across all of these perspectives "students largely demonstrated the fundamental recognition that digital literacy is a developmental process—justifying this topic as an area of inquiry for future work" (p. 156). List (2019) concluded that research is needed for deeper understanding of how pre-service teachers define digital literacy, how their conceptions of digital literacy develop further on in their educational program, and differences in conceptions of digital literacy development across majors. List (2019) acknowledged that a limitation of their study was their method of data collection through open-ended survey responses. While this approach enabled a larger number and range of variability in students' responses to be gathered, methodological approaches such as "interviews and focus groups, may have allowed for richer qualitative data to be collected and for students' responses to be further probed" (List, 2019, p. 156).

List's (2019) study had important implications for my case study research, for it provided the groundwork on what perspectives pre-service teachers may already have about digital literacy development. Furthermore, List (2019) recommended that, in the future, research should collect richer qualitative data through interviews and focus groups, which is what my inquiry has done.

Alongside digital literacy, attention is also growing towards design thinking in education. The next section will overview what design thinking is, its characteristics, and its presence in education.

Design Thinking

Defining Design Thinking

Design is "a process of creative and critical thinking that allows information and ideas to be organized, decisions to be made, situations to be improved, and knowledge to be gained (Burnette, 2005, para. 2). Design thinking originated in the fields of architecture, design, and art before it was applied to management, business, and education (Johansson & Woodilla, 2009; Luka, 2020). For the purposes of my study, design thinking is defined as "a mindset and approach to learning, collaboration and problem solving…for identifying challenges, gathering information, generating potential solutions, refining ideas, and testing solutions" (Teaching and Learning Lab, 2020, para. 1).

Characteristics of Design Thinking

The characteristics of design thinking are closely related to its steps or process. As a creative approach to problem-solving, design firms such as IDEO and the Stanford Design School have popularized its process (Henriksen et al., 2020). According to the Stanford Design School (n.d.), the five major stages of design are as follows: empathize, define (the problem), ideate, prototype, and test. Empathizing refers to understanding human's needs involved in the problem. The process of defining is where the problem at hand is reframed and defined in a human-centric way. Ideating is the next step, whereby many ideas are created in ideation sessions. Prototyping then follows as a hands-on approach to trying out possible solutions. The final step, testing, occurs in the development of a solution to the problem at hand (Stanford Design School, n.d.).

A characteristic of the problem in question is described by Norman (2013), whereby designers search for the underlying "real problem" or "right problem" rather than the initially presented problem. These initial problems are called "wicked problems" as they contain multiple facets and complexities that require creative and innovative thinking and collaboration to tackle (Buchanan, 1992). Only after diverging onto horizons of possible solutions does the designer proceed to converge upon a proposed solution. This first process of divergence and convergence, of expanding and contracting, forms a diamond shape. This is the first diamond of two in the "double-diamond design process model" that was introduced by the British Design Council in 2005. The double-diamond model consists of two divergence-convergence phases or *diamonds*.

Even though it can appear to be a linear process, it is actually quite "cyclical" with the iterations repeating to achieve a "better outcome" (Luka, 2020). As Norman (2013) pointed out, design is ultimately a human-centred process, and also relates to "The Iterative Cycle of Human-Centered Design." The Iterative Cycle of Design consists of four activities, namely: 1) observation, 2) idea generation (ideation), 3) prototyping, and 4) testing. When I think of the characteristic steps of the design cycle, it in fact resembles a circle.

According to Norman (2013), the observing component is for observing the individuals' context and activities to gain deep understanding of the problem that you are hoping to help solve for them. The ideation stage occurs when you generate numerous creative ideas without constraint to possibly solve the problem at hand. This second step is similar to the divergence process of the double-diamond model (British Design Council, 2005). The prototyping stage is where you rapidly build your generated ideas through *mock-ups*, sketches, or drawings so that they can be tested in the testing stage to find a solution (Norman, 2013). Norman (2013)

emphasized thereafter that iteration holds an important role for "refinement and enhancement" of the solution (p. 229).

Design Thinking in Education

Studies on design thinking occurring in schools and teacher education programs implementing design thinking into their preparatory courses are growing, indicating heightening interest in design thinking for teaching and learning in education and academia (Melles et al., 2015). Design thinking is useful for both students and teachers. The notion that students learn through design thinking, for example, posits that students learn and apply knowledge because in doing so they are engaged in doing, in designing or creating, often through personally meaningful projects (Bereiter & Scardamalia, 2003; Gee, 2005). Henriksen (2017) on the other hand, discussed design thinking in the context of a graduate-level design thinking and education course, where an elementary school Spanish teacher within the course used design thinking to design an interdisciplinary STEAM project for their students. Henriksen (2017) suggested that design thinking provides a natural bridge at the interdisciplinary crossroads between STEAM subject areas (i.e., science, technology, engineering, arts, mathematics), and a way for "design and education to connect in teaching" (p. 2). Design is occurring in schools and teacher education and graduate programs, as teachers are being viewed as *designers* of teaching and learning (Norton & Hathaway, 2015).

Henriksen and Richardson (2017) suggested that design thinking as an approach is useful for teachers to utilize because it is a problem-solving approach that can be used strategically and systematically. It is through design thinking that teachers can learn to think of themselves as designers as they empathize with their students to gain new insights into classroom challenges and embrace the uncertainties of school change (Henriksen & Richardson, 2017). Design is also

being taken up as a way for teachers to meaningfully integrate technology into teaching and learning curricula (Norton & Hathaway, 2015), as well as exploring ways in which to teach students digital literacy (Bekker et al., 2015) through digital fabrication. Through a design thinking approach, Bekker et al. (2015) sought to teach children digital literacy with *digital toolkits* (which consist of digital technologies such as FabLab equipment or 3D printers) in schools. The results of Bekker et al.'s (2015) study show potential in creating and refining supports (such as the digital toolkit used) for learning design thinking processes in solving design challenges by making digital products (Bekker et al., 2015).

The literature reviewed so far has focused on the topics of digital literacy and design thinking. The following section will overview social constructivism as the determined theoretical framework and positioning of my study.

Theoretical Framework

A theory is a formulation that predicts, explains, and presents an understanding of phenomena (Abend, 2008). Within the limits of bounding assumptions, theories can at times also challenge and extend existing knowledge. A theoretical framework is a specific perspective that a researcher uses to explore, interpret, or explain the events or behavior of events or subjects they are studying (Imenda, 2014). According to Miles et al. (2019), a theoretical framework "utilizes theory/theories and their constituent elements as the presumed 'working model' that drives the investigation and analysis of a social phenomenon" (p. 15). The purpose of a theoretical framework is to make connections between the problem of the study, research questions, data collection and analysis techniques, and how to interpret study findings (Merriam, 2009). In the following sections, I will examine how social constructivism provides the theoretical underpinning to my study.

Constructivism and Social Constructivism

Constructivism is grounded in the concept that "each individual mentally constructs the world of experience through cognitive processes" (Young & Collin, 2004, p. 375). Constructivism arose out of cognitive and developmental psychology. It was brought to attention through Piaget's theory of understanding children's ways of doing and thinking at various stages of their development (Ackermann, 2001; Piaget, 1977). For Piaget (1957, 1973), knowledge is abstracted from experiences so that formal reasoning can occur. Under Piaget's understanding of constructivism, knowing is viewed as an active process, occurring within the cognitive realm, which associates with the outlined cognitive/rationalist view of knowing (Greeno et al., 1996), as well as the individual cognitive approach to constructivism (Duffy & Cunningham, 1996). The constructivist view emphasizes how the activity of the individual strives "to make sense of the world" (Duffy & Cunningham, 1996, p. 6). As learners encounter new experiences, they reconcile or cognitively reorganize them in accordance with their previous ideas and experiences (Duffy & Cunningham, 1996; Tham, 2019).

For cognitive constructivism, "learning is located in the mind of the individual" and "mental construction is affected by the individual's interactions with the surrounding environment" (Tham, 2019, p. 41). Cognitive constructivism provides the notion that knowledge is organized internally as mental schemas, which are models that represent causality, complex interactions, and relationships between ideas (Duffy & Cunningham, 1996; Piaget, 1977; Tham, 2019).

Social constructivism emphasizes the socio-cultural influences upon individual's minds as central to the meaning-making process (Vygotsky, 1978). Vygotsky (1978) held that even though learning occurs in the mind of an individual, it is actually a result of the social

interactions with others. The sociocultural approach proposed by social constructivism acknowledges that cognition and knowledge are situated in social and cultural contexts (Duffy & Cunningham, 1996, p. 6). The construction of meaning is a reciprocal, communicative process, as "cognitive skills and patterns of thinking are products of the activities practiced in the social institutions of the culture in which the individuals reside" (Tham, 2019, p. 41). It is social interactions and contexts that enable one to self-reflect and make meaning of experience (Vygotsky, 1978; Young & Collin, 2004). Within social constructivism, meanings are first enacted socially before becoming internalized individually, so that in turn, the individual's social actions are guided (Tham, 2019).

Theoretical Framework for the Study

I selected social constructivism as the learning theory that served as the theoretical framework underpinning my research study.

Social communication and interaction are enabled through digital technologies and associated digital literacy, which supports the social constructivist view (Nawaz & Kundi, 2010). Meaning and knowledge is constructed socially for individuals through social and cultural interactions via digital technologies (Klamma et al., 2007).

The design thinking component of my study also contains the underpinning of social constructivism. The design thinking process is an individual and collaborative pursuit to tackle a real-world problem (Norman, 2013). Design thinking encompasses internal and external processes that are both required to gather contextual information, and to interpret and test divergent ideas to converge on a meaningful outcome (Stanford Design School, n. d.; Norman, 2013).

It is by choosing the learning theory of social constructivism that my inquiry will be able to explore pre-service teachers' digital literacy development. Social constructivism will serve as the theoretical framing for my study exploring pre-service teachers' digital literacy development within a design thinking course in a teacher education program.

Positioning the Study

Digital literacy has received increased attention in schools and in teacher education programs because it is becoming a more part of our professional, personal, and civic lives (Anani, 2018; Blum-Ross et al., 2020; Brookfield Institute, 2017; Government of Canada, 2019; Hewitt, 2016). From my review of the literature, I identified a need for further research on pre-service teachers' development of digital literacy within teacher education programs (Blum-Ross et al., 2020; List et al., 2020; McGarr & McDonagh, 2019; Røkenes & Krumsvik, 2014). The focus of my study was to examine administrator's and instructors' perspectives in how pre-service teachers' digital literacy can be developed and fostered in a design thinking course context.

Chapter Summary

From the review of the literature, it is evident that digital literacy is ever more important in education. There is a need for teacher education programs to incorporate digital literacy into their programs to support pre-service teachers in understanding and developing the skills needed in their future teaching. Social constructivism was chosen as my theoretical framework to encompass the joint underpinnings of the topics pertaining to my study. In Chapter Three, I will present and discuss my research design.

CHAPTER THREE: RESEARCH DESIGN

This research studied pre-service teachers' digital literacy development within a Design-based Thinking course at a teacher education program. The research design describes the methodology selected with rationale, research questions, population, and sampling. Methods of data collection and analysis are outlined, along with an explanation of the integrity, boundaries, limitations, and delimitations of the study. This section concludes with an explanation of my role and background as a researcher and ethical considerations.

Methodology

A qualitative research methodology was selected for my inquiry: "Qualitative research is based on the belief that knowledge is constructed by people in an ongoing fashion as they engage in and make meaning of an activity, experience, or phenomenon" (Merriam & Tisdell, 2016, p. 23). Qualitative researchers seek understanding of how people interpret their experiences and make meaning out of them (Merriam, 2009). According to Merriam and Tisdell (2016), constructivism underpins qualitative study, as its central feature is that "individuals construct reality in interaction with their social worlds" (p. 24). To gain understanding of phenomena helps the researcher to interpret or make sense of phenomena and constructed knowledge through the experiences and meanings people bring to them (Denzin & Lincoln, 2011). The qualitative approach to research is an "interpretive" and "naturalistic" one (Denzin & Lincoln, 2011, p. 3), which is one of its strengths, as it focuses on "naturally occurring, ordinary events in natural settings" to "have a strong handle on what 'real life' is like" (Miles et al., 2019, p. 7).

The purpose of qualitative research is to "*understand* how people make sense of their lives and their experiences" (Merriam & Tisdell, 2016, p. 24). A qualitative approach brings with it assumptions and theoretical frameworks that inform the study of the research problem

(Creswell & Poth, 2018). The collection of data occurs in the natural setting of the people and phenomena under study so that an inductive data analysis can occur to establish emergent patterns or themes (Creswell, 2013; Merriam & Tisdell, 2016).

A qualitative case study approach was selected for this study on digital literacy. My inquiry aligns with Merriam's (2009) approach to case study due to constructivist epistemological and theoretical underpinnings. Merriam's (2009) perspective is that reality is constructed, and meaning is made through social interactions, which aligns with both my philosophical worldview and theoretical framework for this qualitative case study. Merriam and Tisdell (2016) defined qualitative case study as "an in-depth description and analysis of a bounded system" (p. 39). The defining feature of case study is that it is bounded, "meaning that it can be defined or described within certain parameters" (Creswell & Poth, 2018). The phenomenon must be intrinsically bounded to be considered a case (Merriam & Tisdell, 2016). While other types of research such as phenomenology or ethnography are defined by the focus of the study, case study research is rather defined by the unit of the analysis, which is the bounded system (Merriam, 2009; Merriam & Tisdell, 2016). My case study was bounded to an undergraduate Design-based Thinking course offered in one Canadian teacher preparation program. Thus, my research can be best described as an exploratory case study designed to gain understanding of pre-service teachers' digital literacy development within a Design-based Thinking course at a teacher education program. An exploratory case study approach can feature the "power of qualitative data" to explore new ideas, strategies for discoveries, and develop hypotheses (Miles et al., 2019, p. 8), especially for emerging areas of research (Mills et al., 2010).

Qualitative inquiries feature data that can provide rich and thick descriptions (Merriam & Tisdell, 2016). Case study research is well suited to providing an in-depth understanding of a case when the research problem seeks to understand a phenomenon at depth (Creswell & Poth, 2018). Through my study. I hoped to gain deeper understanding of the nature of digital literacy development of pre-service teachers within a Design-based Thinking course. I anticipated that I would uncover strategies, views, processes, and factors that contribute to pre-service teachers' digital literacy development.

Research Questions

An in-depth exploration of how pre-service teachers' digital literacy is understood and developed can contribute to the research of how teacher education programs implement the development of digital literacy. The following was the main research question that guided this case study: How do pre-service teachers develop digital literacy within a Design-based Thinking course in a teacher education program? Through data collection, I investigated the opportunities in one teacher education program for pre-service teachers in developing digital literacy in the Design-based Thinking course.

Population and Sampling

The population consisted of pre-service teachers (approximately 400), instructors (approximately fourteen) of the Design-based Thinking course, and administrators (approximately sixteen) from the teacher education program. The population of instructors was those teaching the Design-based Thinking course; the population of pre-service teachers was drawn from those in the last semester of their B.Ed. program (from three pathways of either two-year after-degree on-campus or community-based; four-year on-campus or community-based; or five-year concurrent on-campus). Such a population selection "reflects the phenomenon of

interest" (Merriam & Tisdell, 2016, p. 97), as it was my experiences at this teacher education program that initially sparked my interest in the phenomenon of pre-service teachers' digital literacy development, and ultimately conducting this study.

Sampling emphasizes—in-depth—an information-rich singularity (Merriam & Tisdell, 2016; Patton, 2015). Convenience sampling was the type of sampling used, given factors such as "time, money, location, [and] availability of sites or respondents" (Merriam & Tisdell, 2016, p. 98). All pre-service teachers enrolled in the Design-based Thinking course received the invitation to participate in the study. The goal was to interview up to fifteen pre-service teachers who are enrolled in the Design-based Thinking course, with each interview being from thirty to forty-five minutes in length.

I initially planned to select for interview a convenience sample of the first fifteen pre-service teachers who volunteered. However, no pre-service teachers volunteered to participate in the study. A convenience sample of instructors was planned to be selected for the focus group interviews with as many as possible participating in the focus group interview. Five instructors volunteered to participate in the study. The duration of each focus group for this study was from forty-five to sixty minutes. The administrators of the teacher education program (e.g., Associate Dean and program coordinators) were invited to participate in an individual interview. The length of the interview was approximately thirty to forty-five minutes in length. One administrator participated in the study during the winter semester.

Methods of Data Collection

Multiple methods of data collection are often used in case studies for triangulation and increasing credibility and internal validity (Merriam & Tisdell, 2016). Three sources of data

were used for this inquiry: an individual interview with an administrator, focus group interviews with instructors, and documents.

The first data source was the individual interview with an administrator of the teacher education program. Semi-structured interviews are a useful format for providing flexibility between open-ended and structurally worded questioning as to allow for the "researcher to respond to the situation at hand…and to the innovative ideas on the topic" (Merriam & Tisdell, 2016, p.111). The following is a sample of the questions asked:

- How they would define digital literacy;

- How digital literacy is being developed in the Design-based Thinking course;

- What role teacher education programs have in developing pre-service teachers' digital literacy; and

- Factors for consideration in digital literacy development.

The second data source was focus group interviews with five instructors of the Design-based Thinking course. Due to the instructors' schedules, two focus group interviews were conducted. A unique characteristic of focus group interviews is the interactive discussion that can generate data and "lead to a different type of data not accessible through individual interviews" (Hennink, 2014, p. 2–3). A focus group interview was chosen for data collection for participants to discuss and share their views and experiences for a generative data source to compliment the individual interview of the first data source. Focus group interviews occurred after the course was completed during the winter semester.

Due to this study being conducted during a pandemic, all interviews with instructors and administration took place synchronously using videoconferencing technology. Each interview was audio-recorded and transcribed verbatim (See Appendix A for interview questions).

Documents were the third data source. Documents refer to "a wide range of written, visual, digital, and physical material relevant to the study" (Merriam & Tisdell, p. 163). The source documents for this inquiry were identified by the administrator during the individual interview, as well as what was provided online from the program's website. The documents included the Design-based Thinking course outline and online information accessible on the teaching program website. Documents are the data sources "most typically a natural part of the research setting and do not intrude upon or alter the setting in the ways that the presence of the investigator might when conducting interviews or observations" (Merriam & Tisdell, p. 162).

Methods of Data Analysis

Data analysis in qualitative research occurs concurrently with data collection to support the "back and forth between thinking about the existing data and generating strategies for collecting new, often better, data" (Miles et al., 2019, p.62). To analyze individual interviews with the administrator, focus group interviews with instructors, and collected documents, I used Saldaña's (2016) two cycles of coding and thematic coding. Codes are "labels that assign symbolic meaning to the descriptive or inferential information compiled during a study" (Miles et al., 2019, p. 62). Coding is analysis, as it represents deep reflection and interpretation of the meaning of data collected (Miles et al., 2019).

First Cycle coding methods occur when data units are assigned initial codes to summarize data. Second Cycle coding methods group the initial First Cycle "summaries into a smaller number of categories, themes, or concepts" (Miles et al., 2019, p. 79). Analysis of the administrator interview data took place before that of document analysis, since the administrator identified source documents (i.e., the course outline) during their interview.

Thematic coding is the specific coding method I used for both cycles of coding (Saldaña, 2016). A theme is "an *extended phrase* or *sentence* that identifies what a unit of data is *about* and/or what it *means*" (Miles et al., 2019, p. 73). Table 1 is a sample of the thematic coding of the data I created during the analysis stage. First Cycle coding of the individual and focus group interviews were used as initial codes, which also were used to identify emergent themes in the collected documents. As shown in Table 1, an example of First Cycle coding for this inquiry was using digital tools, purposeful, and ethics. Data reduction occurred as I grouped these First Cycle codes together into defining digital literacy. At this point, I entered Second Cycle coding, which was the thematic analysis of the data to identify the emergent themes (Saldaña, 2016).

Table 1

A Sample of Thematic Coding

Themes	Subthemes	Sub-subthemes
Defining Digital Literacy	Using digital tools Purposeful Ethics	
Developing Digital Literacy Capacity with Pre-service Teachers	Embedded	Strengths Challenges
How Pre-service Teachers Experience Digital Literacy in Current Program	Formal Structured Informal	
Academic Staff Perceptions and Understanding of Digital Literacy	Implicit Explicit	
Developing Digital Literacy in Pre-service Teacher Program	Challenge with Digital Literacy in Design-based Thinking Course Factors that Influence the Development of Digital Literacy	Focus Risk-taking Instructor Modelling

Integrity of the Study

It is important that all research is concerned with credible and trustworthy knowledge that is ethically sound. Conducting qualitative investigations necessitates such integrity, specifically internal validity, reliability, and external validity (Merriam & Tisdell, 2016).

Internal validity "deals with the question of how research findings match reality" (Merriam & Tisdell, 2016, p. 242). Internal validity prompts the researcher to ponder upon whether their findings capture what is really there, and what they think they are observing and measuring. In qualitative research, researchers investigate people's multiple constructions and understandings of reality. One way that qualitative researchers come closer to reality and its interpretation is through themselves being the primary instrument of data collection and analysis rather than an interjectory instrument between researcher and participant (Merriam & Tisdell, 2016). For my study, I collected the data myself, which Merriam and Tisdell (2016) pointed out is a strength in qualitative research for internal validity.

To ensure validity and reliability in this research, I used triangulation. Triangulation is key, especially for inquiries of an interpretive-constructivist perspective (Merriam & Tisdell, 2016) that "increases credibility and quality by countering the concern (or accusation) that a study's findings are simply an artifact of a single method, a single source, or a single investigator's blinders" (Patton, 2015, p. 674).

Triangulation in this study employed the three sources of data so that I could compare and cross-check them in relation to one another as a "powerful strategy for increasing the credibility and internal validity" (Merriam & Tisdell, 2016, p. 245) of my research. Data from instructors and the program administrator provided rich information from a variety of perspectives on digital literacy development and opportunities for developing it in the Design-based Thinking course.

Researcher positioning is another useful strategy for ensuring research integrity. Researcher positioning involves the investigator explaining their "assumptions, experiences, worldview, and theoretical orientation to the study at hand" (Merriam & Tisdell, 2016, p. 249).

Peer examination strengthens the integrity of this work, since "graduate students have this process built into their thesis or dissertation committee" (Merriam & Tisdell, 2016, p. 249). During this inquiry, I shared and discussed the research process (i.e., data collection, interpretation and analysis, and findings) with my supervisor, which provided an iterative process of review and feedback.

Reliability is the next component central to the integrity of research, which Merriam and Tisdell (2016) explained as being "the extent to which research findings can be replicated" (p. 250). Even though the replication of a qualitative study will not provide the same results, "this does not discredit the results of any particular study," for "there can be numerous interpretations of the same data" (Merriam & Tisdell, 2016, p. 251). For reliability in qualitative research, it is important to consider whether the data results are consistent with the data collected (Lincoln & Guba, 1985). A qualitative study can be considered dependable if study findings are consistent with the data presented (Merriam & Tisdell, 2016). To ensure reliability, I employed triangulation, peer examination, researcher positioning, and the audit trail (Lincoln & Guba, 1985; Merriam & Tisdell, 2016).

Triangulation, peer examination, and research positioning to ensure internal validity have already been discussed. The audit trail "describes in detail how data were collected, how categories were derived, and how decisions were made throughout the inquiry" (Merriam & Tisdell, 2016, p. 252). Throughout the process of conducting this study, I recorded memos (i.e., my reflections, questions, decisions for data collection, interpretation, and analysis) to log and explain the findings of the study as an authentication of the study findings for those who read it (Merriam & Tisdell, 2016; Richards, 2015).

Another component for integrity in research, external validity (also known as transferability), means "the extent to which the findings of one study can be applied in other situations," as in how "generalizable" the results are of a study (Merriam & Tisdell, 2016, p. 253). I selected a single case to understand in-depth rather than what is generally true for many, and employed rich, thick description to enhance the possibility of qualitative study results transferring to another setting (Merriam & Tisdell, 2016). As a strategy, a rich, thick description consists of me describing in detail the particular context and findings of the study so that a reader can assess similarities between that study and another study with a like context (Lincoln & Guba, 1985). To enable external validity, I described the setting and participants of my study and provided detailed description of the findings with adequate evidence (i.e., memo notes, quotes from participant interviews, and study documents) (Merriam & Tisdell, 2016).

Boundaries of the Study

Setting boundaries are important for connecting directly to the study research questions and defining case aspects that are within the limits of the researcher's time and budget (Miles et al., 2019). Given these considerations, this research design was bounded to one course (Design-based Thinking course) in a Canadian education program. This study was conducted during the COVID-19 pandemic. Given the pandemic, students completed the course online.

Limitations and Delimitations

Limitations

A first limitation of this case study was the convenience element of the purposeful sampling, as "time, money, location, [and] availability of sites or respondents" (Merriam & Tisdell, 2016, p. 98) were factors in bounding the case and selecting the sample. Second, this inquiry was conducted during a pandemic, which could have contributed to the limitation of a

limited number of participants in the study. A third limitation of this inquiry resides in the chosen methodology. This case study seeks to gain an in-depth understanding of pre-service teachers' digital literacy development in a Design-based Thinking course rather than generalizing findings (Merriam & Tisdell, 2016).

Delimitations

Delimitations were set in place for this study. The study was delimited to one Canadian teacher education program. The delimitation was to program administrators and pre-service teachers and instructors of the Design-based Thinking course taught in Winter 2021. This bounded the case for specific relevance to the inquiry of digital literacy development.

Ethical Considerations

The ethics application for this study was approved by the University of Calgary's Conjoint Faculties Research Ethics Board (CFREB). All participants were recruited through online correspondence (i.e., recruitment email sent through approval of the teacher education program). The participants were asked to sign consents before data collection began. Participants were informed that partaking in the study was voluntary, and that they had the right to withdraw from the study at any time.

Background and Role of the Researcher

My desire to conduct this study came from two primary factors. First, having gone through this teacher education program myself two years prior, I personally experienced the increasing emphasis on digital literacy. Education program courses were placing efforts towards teaching and learning with digital technologies, which at times required pre-service teachers to learn how to purposefully link curriculum to the use of technologies (i.e., using Lego Mindstorms and programming software for interdisciplinary subject lessons). Second, my

interest in pursuing research and investigating digital literacy was largely influenced by the undergraduate research award grant work I conducted on digital literacy and scientific literacy during one summer of my teacher education program.

My experiences prompted me to recognize the importance of developing pre-service teachers' digital literacy and opportunities to develop it. My inquiry focused on an in-depth exploration of how digital literacy development is understood in the bounded context of a Design-based Thinking course at a teacher education program. I attended the same teacher education program where this study was conducted and acknowledge the potential of bias. To reduce bias, I kept records of my memos (i.e., reflections, questions, and decisions for data collection, interpretation, and analysis). Moreover, I employed peer examination and the triangulation of sources (i.e., three sources of data) to strengthen the internal validity of the work and authenticate consistency throughout the study (i.e., consistency between the data collection, analysis, and findings).

Chapter Summary

In this chapter, I discussed the selection and rationale for this qualitative, exploratory, particular case study, and outlined its boundaries, sampling, limitations, and delimitations. Integrity, ethics, and researcher role were thoughtfully considered to strengthen internal validity, reliability, and external validity in the inquiry. In Chapter Four, I will discuss the findings of the study.

CHAPTER FOUR: FINDINGS

This chapter begins with a description of the context of the study, along with the demographic information about participants. Thematic analysis from the semi-structured interview, focus groups, and documents data are presented. The five themes with subthemes are discussed.

Context of the Study

A single case study was conducted during the Winter 2021 semester, which occurred during the COVID-19 pandemic. The study was bounded with regard to the Design-based Thinking course that normally is offered on campus in a face-to-face setting. Due to the pandemic, the course was offered online for the first time.

The purpose of this qualitative case study was to explore understanding of pre-service teachers' digital literacy development within a Design-based Thinking course in one teacher education program in western Canada. The teacher education program has approximately 1200 pre-service teachers enrolled, which includes both the on-campus and community-based pathways for the Bachelor of Education (B.Ed. degree). Three routes are possible for the two pathways. The on-campus, two-year after-degree B.Ed. program is the largest program, followed by the on-campus concurrent B.Ed. program, and the on-campus four-year B.Ed. degree. For the community-based pathway, the four-year B.Ed. program has the greater number of students enrolled, in contrast to the two-year after-degree community-based pathway. While a variety of subject specializations are offered for each pathway, some specializations contain a larger portion of pre-service teachers (i.e., secondary social studies, early childhood education), and others a smaller portion (i.e., secondary languages such as French). Courses are taught by academic staff that includes both faculty members and sessional instructors. In the Fall semester

prior to this study, approximately 150 to 175 academic staff members taught in the program along with some teacher assistants (TA).

The Design-based Thinking course is a required course for all pre-service teachers in each pathway. This course is completed in the last semester of the final year in their program. The course was designed to foster pre-service teachers' design principles and mindsets towards inquiry. Other learner intentions of this course include understanding how design models can be used to develop solutions and ways to address educational problems and societal challenges. Pre-service teachers are encouraged in this course to be reflexive practitioners by giving and receiving feedback on their ongoing, iterative solutions to a design problem.

Participant Demographics

The case study invited all academic staff who were assigned to teach the Design-based Thinking course, along with the administrators of the B.Ed. program. Six academic staff completed the informed consent form to participate in the study, which included one administrator and five instructors who taught the course. One instructor had been teaching at this university since 2012, two had been teaching at this university since 2013, and two instructors have been teaching at this university since 2017. Two of the academic staff members were sessional instructors, and three were faculty members. Of the five people who taught the course, one had taught it three times, one had taught it two times, and three had taught it for the first time.

The course is offered to the pre-service teachers as an elementary or secondary or a combined section. One instructor had taught a combined course section comprised of both elementary and secondary specializations. Two instructors only taught a secondary or an elementary section. Two taught both an elementary section and a secondary section. The term

instructor is used in the rest of the chapter to refer to both faculty members and sessional instructors.

Themes

The findings of this study are organized into themes. These themes emerged from coding analysis of the data. The following five themes are presented were described in the chapter:

1) Defining digital literacy;

2) Developing digital literacy capacity;

3) How pre-service teachers' experience digital literacy;

4) Academic staff perceptions and understanding of digital literacy; and

5) Developing digital literacy in a teacher education program.

Defining Digital Literacy

In the interviews with the five instructors and one administrator, they expressed their understandings of digital literacy and identified the following two key attributes of digital literacy: digital literacy is 1) about being able to use digital technologies or tools and 2) being purposeful in how one uses digital technology, including elements of access and context and *why* a given digital technology is used. A pedagogical perspective is brought forward in determining the purposeful use of digital technology, as well as the examination of ethical behaviour and digital citizenship.

Using Digital Tools. All six participants began by describing digital literacy as being able to use digital tools. One participant described digital usage as "the ability to use digital tools…and environments to achieve one's goals." This indicates that digital literacy involves an ability to use digital technologies. Another noted that digital literacy helps to understand and to make sound decisions within context. There was the notion that using digital tools requires not

just ability to use, but to understand its context-dependent nature. Two other participants furthered this notion by explaining digital literacy is about the how in using "the digital tools that are available to us" and to "know how to use them [digital tools] or be willing to learn how to use them." Digital literacy is not just about being able to use digital technologies, but *how* we use them given our context and access. Additionally, being "comfortable enough" in using digital technology or "comfortable enough to learn how to use them" was another element disclosed during the interviews. The concept of comfort was a theme touched on recurrently throughout the interviews.

Purposeful. Purposeful integration was identified as a key attribute of digital literacy. Participants defined digital literacy as "coming from an educational perspective" and recognized "pedagogical sensibilities" are important for digital literacy. An instructor shared an example about how SMART Board® interactive displays were treated as just "glorified whiteboards" when they were first introduced into the classroom, since "people were just using…the pens to mark-up the board, and not fully understanding the potential." As noted by one participant, "it's not just about the tools, it's also about how do we employ those tools so that we are not simply using technology for the sake of using technology." Intentionality in the use of technology in support of learning was a theme throughout the interviews.

Upon purposeful considerations of *why* a digital technology is used, ethics and ethical behaviour online was likewise noted by participants. As part of their definition of digital literacy, participants elaborated upon their definition of digital literacy through such phrases as "access to technology," "who benefits from technology," and "power relationships." The administrator extended this notion and linked ethics to digital literacy through what they called the *why* component of using digital technology:

But there's also a why component. And that to me is the biggest one. So, why are we using this technology. And this where all of the ideas around ethics and digital citizenship come in, and how do we, you know, for lack of a better term, how do we behave in that digital world.

According to the administrator's quote above, definitions of digital literacy should acknowledge the inherent responsibilities associated with using digital technologies. The example provided by the administrator was regarding learners (i.e., middle school and/or university) at times using digital technologies in inappropriate ways since they can often do so anonymously. Purposefulness for digital literacy refers to not only how but why digital technologies are used for learning.

Developing Digital Literacy Capacity

Need for Being Embedded. When discussing pre-service teachers' digital literacy during the interviews, it was evident that participants perceived the development as being *embedded*. According to the administrator, no course within this particular teacher education program solely focuses on digital literacy. Rather, digital literacy is woven into the program. The administrator explained the rationale for this embedded approach is that one course for digital literacy would be "a bit of a fool's errand because these things change so quickly that by the time you got the course developed it would be outdated."

Program Strengths in Embedding Digital Literacy. Two major strengths in using an embedded approach in this teacher education program were identified. The first strength identified was that of this program's *authentic embeddedness*. According to the administrator, the teacher education program was intentionally designed so that digital literacy was embedded in it. As the administrator explained, it is through an embedded digital literacy design that

academic staff can role model how "technology becomes part of what you're doing, and not something that gets added on." The emphasis is on using technology in a way that is authentic to the learning task. The term authentic embeddedness was shared by the administrator regarding the digital literacy approach taken by the teacher education program towards digital literacy, however, no definition was provided. The embeddedness of digital literacy was referred to as being "embedded and woven throughout the program" and not "a lot that's actually explicitly written in the course outline." Rather, they indicated that digital literacy was authentically embedded in perhaps some examples of learning tasks with "digital aspects" to them.

The second strength identified by the administrator resided in the Faculty's Office of Teaching and Learning, which offered optional online workshops that pre-service teachers could attend. These workshops were offered in response to the sudden shift to online learning during the COVID-19 pandemic. It was explained by the administrator that the B.Ed. program did not take on this initiative since they were not in a position "to fit one more thing" into the program unless something got "taken out." The administrator said that these workshops were helpful for pre-service teachers who "feel passionate" about "learning how to teach online" and are projected to "continue well into the future."

Program Challenges in Embedding Digital Literacy. When discussing digital literacy development in relation to the Design-based Thinking course, access to and comfort in using digital technologies were identified by the instructors as being a challenge. Two instructors spoke about the kind of access that pre-service teachers had to digital technology. One explained and how there was "the issue of accessibility," especially during the pandemic, and how that caused "a little bit of a barrier that way, just with the financial, having to pay," A second instructor explained that "in terms of accessibility, even for Zoom…some of my students had

like a very old laptop, so they couldn't update…so some of the functionalities were not available." This participant expressed that the effects of having older digital technologies resulted in the inability for updates to occur for software used in the course (i.e., Zoom teleconferencing software). An instructor continued, "we assume that [university] students will have enough resources…but that may not be true for everyone" and that "we can't expect them to have the latest laptop for online learning." Thus, the rapid shift to online teaching and learning due to the COVID-19 pandemic has brought to the attention of instructors that all pre-service teachers cannot be expected to have up-to-date digital technologies for software usage in the course.

Similar to the challenge of accessibility, all five instructors noted that they had to work around pre-service teachers' comfort levels in using digital technologies within the course. For example, an instructor expressed the challenges due to "real trade-offs" between what was possible and what pre-service teachers were comfortable with. The instructor elaborated by speaking about how Zoom videoconferencing and Google tools were the "default platform"; however, these tools were "not necessarily the best possible tools" in terms of "theoretical affordances." Instead, digital technologies such as those aforementioned became the "best choices" because "everyone was comfortable using them." In another example, it was noticed that the shift to online learning from face-to-face was "interesting" to see how "a) people are overwhelmed by this very quickly, and b) some of that is just a function of is it going to change so they become familiar with it." The same instructor explained that there are different levels of digital literacy and, for the context of this Design-based Thinking course, there should be an established baseline that everyone is "the most comfortable with."

Multiple instructors referred to the impact that the COVID-19 pandemic had on course delivery in terms of the shift from face-to-face to online and what that meant for them in terms of determining "what we can do, and what people can understand and also handle." For instance, even though Zoom was established as the primary means of videoconferencing technology for the duration of the course, an instructor noted that some pre-service teachers had to use their phones in their car for Zoom sessions, which limited their capabilities in using the technology (i.e., working on documents). The instructor understood such occurrences as being "COVID related," as well as there being "mobility kind of issues" for online learners overall. The shift to online learning due to the COVID-19 pandemic uncovered unforeseen challenges and assumptions that instructors may have had (i.e., that pre-service teachers have access to new digital technologies).

How Pre-service Teachers' Experience Digital Literacy

Planned vs. Responsive. Based on the six participants' responses, it was noted that pre-service teachers experience a range of digital literacy in their teacher education program from formally planned to informal. Within the course, the theme *formal structured* indicated that participant referenced such items as overall course learning intentions, learning tasks, and planning, while *informal* referred to ongoing adjustments made throughout the course sessions. For example, an instructor expressed that instructors had their "technological tools figured out before the course started" since that was "their role," which indicated a more formal, structured approach.

In contrast, a more informal approach was also noted in the course in that they needed to "be responsive to what the students need and what the course content needs." In particular, instructors indicated how flexibility was needed in shifting to and navigating online teaching and

learning (due to the COVID-19 pandemic). For example, pre-service teachers' accessibility to digital technologies became a factor in the types of applications and course activities instructors could try out with their classes. An instructor elaborated that they [instructors] had "to be really flexible like you could be excited about doing something exciting, but then, you know, it may not work for some students." Instructors found they were adjusting their expectations for selecting and using digital technologies with pre-service teachers on an ongoing basis during the course.

Academic Staff's Perceptions and Understanding of Digital Literacy

Implicit vs Explicit. All six participants discussed digital literacy as being an implicit component of the course. Five participants used terms such as implicit, explicit, or embedded. In regard to digital literacy development in the course, the administrator highlighted that there was not much that was "actually explicitly written in the course outline" other than "examples perhaps of learning tasks where you can see the digital aspects to it," since "these things are embedded and woven throughout the program." From the document review of the course outline, it is clear that there is nothing written explicitly regarding digital literacy in the course; the course outline just mentions using web-based applications such as Google Docs and Desire2Learn (D2L) software for learning task collaboration, documentation, and final showcase of learning.

In addition, the instructors likewise echoed reference to the course outline's focus on *design-based thinking*, and that digital literacy "was implicit." Another instructor expressed that, "I would say I didn't teach digital literacy at all. I had expectations about using the technology." These implicit expectations included that preservice students "were already quite familiar with Zoom" and, for example, "how to you know, share their screens," and that the instructor would

"maybe once in a while…give them a few clues how to maximize their time for collaboration."
For this instructor, "it was about the goals of the course of teaching how to think in designerly
ways and how to engage in the design process…it wasn't about digital literacy."

An example was shared by an instructor on how a group of pre-service teachers in their
class were creating a website for their final presentation, which inherently included them having
to think about organizing the content "in a digital format." The instructor continued that these
were "not skills that we [instructors] taught" and that "they [pre-service teachers] pick up
through the nature of the task…but not necessarily with the explicit skill development that
happens in the course." In terms of the assessment of the pre-service teachers' presentations
(which included a variety of digital formats), an instructor expressed that "there was nothing….
in terms of assessment to be looked at [in] their digital literacy," and that it was "not necessarily
about the digital aspects." Another instructor thought that since pre-service teachers were making
a "presentation on an online environment" and were "assessed on their presentation and how
they presented things," they guessed that digital literacy was assessed in that way.

Participants' comments generally focused on an embedded approach to digital literacy,
and how digital literacy was not explicitly outlined as a course objective. However, when asked
about providing their recommendations for developing digital literacy in the B.Ed. program, they
expressed how the effect of the COVID-19 pandemic on teaching and learning should be taken
into consideration moving forward. Instructors discussed the assumption that pre-service
teachers were being prepared to mostly teach in a face-to-face classroom setting. Yet, as one
participant reported, the resulting implications for future considerations during and after the
COVID-19 pandemic need to be considered. This instructor noted "it's an expectation out in the
classroom at all grade levels that you engage in digital literacy" and it needs to be "embedded" in

the work of teaching and learning. This person went on to say that it needs to be explicitly noted

so that the instructor knows "what parts of digital literacy are present in the course." At the

conclusion of the focus group, participants indicated that digital literacy is becoming

increasingly important and suggested to address it more explicitly moving forward. Due to the

timed nature of the scheduled focus group, participants did not elaborate further on this train of

thought of how digital literacy can be more explicitly addressed.

Developing Digital Literacy in a Teacher Education Program

The B.Ed. program administrator emphasized the importance of post-secondary

institutions in having the "biggest role" in "the *why*, not necessarily the how" in developing pre-

service teachers' digital literacy. For example, the administrator mentioned the program's role in

providing digital tools and embedding opportunities for pre-service teachers to learn how to use

the technology and more importantly, to understand *why* they should use them. The administrator

noted how "discussing pedagogical sensibilities become important" and how teaching online

"needs to look different" as "it is not simply transferring an on-campus, like a face-to-face

experience online." The administrator also indicated that online pedagogical workshops provided

to pre-service teachers optionally by the Office of Teaching and Learning were an opportunity to

learn more about the pedagogical issues in relation to online teaching.

As previously discussed, embedding digital literacy is considered important in

developing pre-service teachers' digital literacy in this teacher education program. The

administrator spoke of how technology "fits into" courses such as those focusing on a course

focused on Pragmatics, subject specialization courses, and the STEM (Science, Technology,

Engineering, Mathematics) course in an authentic way. According to the administrator, the

"courses themselves decide" where digital literacy "makes sense in some places and not in

others" and "sits more comfortably." The instructors echoed the administrator's thoughts, whereby "digital literacy should just be embedded…kind of background throughout almost every single course along with our notions of learning theories."

The administrator and one instructor held different perspectives about pedagogy in online teaching and learning. The administrator expressed how teaching online is "not simply about transferring an on-campus, like a face-to-face experience online….it needs to look different." On the other hand, one instructor expressed the view that when teaching online they do "exactly the same thing" whether it's "face-to-face or in a digital environment, it's the same," according to their pedagogical practice. Contrasting to the administrator's view, the instructor felt that they were "not really sure how [they] would define digital literacy right now, because…a mere reflection of what [they] would have done normally in the classroom, [they're] doing in a digital environment." All participants in the study shared a similar view and experience with digital literacy with the exception of this one instructor.

Challenge with Digital Literacy in Design-based Thinking Course. It was evident in the study that the course is not focused on digital literacy**.** Rather, from the interviews it was noted by the participants that working with digital technologies was a way in which to reach the goals of being designerly in accordance with the learning intentions for the course. For example, one instructor reported that digital literacy was not the focus of the course. Rather, it was about the use of digital technologies in achieving the learning intentions. As described, the instructors primarily focused their efforts towards the course learning intentions on design-based thinking, and how digital technologies can support them pedagogically in reaching the identified learning intentions. An instructor expressed it, "How we can use…this digital environment, whether we want to call it digital literacy or developing digital literacy. How do we use these digital tools as

a learning tool? It's just simply a tool." Overall, when asked about digital literacy during the focus group interview, instructors had a tendency to interchangeably use the terms *digital technology* and *tools*.

Factors that Influence the Development of Digital Literacy. It should be noted that instructors spoke about factors for pre-service teachers' digital literacy development as course participation in "online learning" rather than to "specifically help them [preservice teachers] with digital literacy."

From the data, two factors were identified by the instructors that influence the development of digital literacy in a teacher education program. First is the fostering of risk-taking by pre-service teachers. All participants viewed risk-taking as an important factor in developing pre-service teachers' digital literacy. One participant elaborated that there are some critical elements for developing digital literacy such as "exploring things together with students" and giving pre-service teachers "more agency in thinking about how does technology help in collaborating and outing your ideas into visual form, or visible to other people." Instructors were open in being willing to explore and work with new digital technologies and applications alongside pre-service teachers. For instance, when an instructor wanted to "do a brainstorm" but had to figure out how do make "sticky notes" with the class in an online environment, they invited pre-service teachers to also think of what "forms of [digital] technology" and applications could be brought in to try out and do so together.

Problem-solving was inherent to the process of instructors trying new ways to teach the course in an online environment. For example, an instructor shared their experience of trying out using a new videoconferencing application called Gather Town for small group work versus the Zoom application used in all the pre-service teacher courses during the pandemic. Trouble-

shooting the video and audio requirements for Gather Town occurred that was different from Zoom. Even though a preservice teacher in the class helped to find a way to resolve the matter as they "figured it out together," the instructor noted that the experience of trying Gather Town "was a little bit of a distraction" for the pre-service teachers. Additionally, despite the feedback from pre-service teachers being generally positive in trying a different application for group work, the instructor realized that it was "too much" and "hugely confusing" for some of them. Inherent to the outcomes of taking risks together with pre-service teachers was learning what worked well and what could be changed next time in the course.

Second, instructor modelling was another factor deemed as important in developing pre-service teachers' digital literacy in a teacher education program. Modelling was spoken of by all instructors. For one instructor in particular, modelling was "number one" in giving consideration towards pedagogy and digital literacy development. For this instructor, "digital literacy for a teacher is around pedagogical practice" and about instructors "modelling [their] own growth in front of their students" in digital environments. Other instructors spoke of modelling as paying "very careful attention to pedagogy," since what might be "intuitive" for instructors might not be for pre-service teachers. Another instructor reflected upon how they were "not sure" how well they modelled "online learning," but pre-service teachers experienced "one" model from their instructors in the Design-based Thinking course for online learning. Instructors were also intentional in their modelling so that they "would almost walk alongside [their] students so that they [students] could feel um inspired and successful in navigating through collaborating in an online space." Resonating comments on modelling were also made by the administrator: "what we're really role modeling is how technology becomes a part of what you're doing, and not something that gets added on." From these data, it was evident that the purposeful and

intentional use of digital technology in support of learning and teaching helps to foster the development of pre-service teachers' digital literacy.

Chapter Summary

In this chapter, I presented the findings of the data of this qualitative case study. The five themes were identified and discussed based on the analysis of the data. In Chapter Five, I will provide a discussion of the findings in relation to the literature.

CHAPTER FIVE: DISCUSSION

This case study explored administrator's and instructors' perspectives on how pre-service teachers develop their digital literacy within a design-thinking course in one teacher education program. This chapter begins with a reflection on my research question and a revisiting of my assumptions. A discussion of the findings follows, as they pertain to the literature in response to the research question focused on the development of digital literacy via a design thinking course context. The chapter concludes with a discussion of a conceptual framework designed to support pre-service teacher development of their digital literacy.

Research Question Reflection

This case study was guided by the research question: How do pre-service teachers develop digital literacy within a Design-based Thinking course in a teacher education program? While I designed this study with the intention to include pre-service teachers' perspectives on their digital literacy development, only the instructors and administrator participated. Therefore, my study only explored administrator's and instructors' perspectives of pre-service students' digital literacy development. I recognize the misalignment between my research question and the participant data collected, but upon reflection have decided to proceed with answering the research question from the perspectives of the instructors and administrator. My reasoning resides with my chosen philosophical worldview and chosen theoretical framework of social constructivism. I view that multiple realities are constructed and shaped through our interactions with others and lived experiences, and hence in research reality is co-constructed between the researcher and participants (Creswell & Poth, 2018). Axiologically, "individual values are honored and are negotiated among individuals" (Creswell & Poth, 2018). I recognize the value of

the administrator and instructors' perspectives and gaining insights for how pre-service teachers develop digital literacy within a Design-based Thinking course in a teacher education program.

Revisiting Assumptions

This study was based on two assumptions. The first assumption was that digital literacy is an important literacy to be developed with pre-service teachers. Previous literature on pre-service teachers in teacher education programs aligned with my assumption about the importance of digital literacy for pre-service teachers (i.e., Hauck & Kurek, 2017; List, 2019), but the findings of my research did not. While digital literacy was acknowledged by the participants, they shared in the interview and focus groups that digital literacy was not the focus of the Design-based Thinking course and that it was implicit. There was no mention of digital literacy in the course outline. An instructor remarked that they did not teach pre-service teachers digital literacy. Rather, there were expectations for using digital technology in the course. Based on my findings in this particular course, digital literacy was not an area of focus for pre-service teachers to develop.

The second assumption for this study was that teacher education programs have a role in preparing pre-service teachers to teach digital literacy. My review of the literature confirmed this assumption (i.e., McGarr & McDonagh, 2019; Røkenes & Krumsvik, 2014). The findings of my study mostly aligned with my assumption. The teacher education program administrator emphasized that post-secondary institutions have the largest role in developing pre-service teachers' digital literacy. The administrator elaborated that it is important to teach pre-service teachers pedagogical sensibilities when using digital technologies. Specifically, the administrator explained that teaching in an online environment must look different than when teaching in a face-to-face setting. Pedagogically, teachers should take into account how to use digital

technologies in a purposeful way. All participants in the study held a similar view to the administrator, except for one instructor who shared that the way they teach online and face-to-face are exactly the same. From the findings, it became evident that the participants did not have a common understanding of the definition of digital literacy. When asked about digital literacy, the participants mostly focused on the element of using digital technology and did not elaborate on other important elements of digital literacy (i.e., critiquing digital texts, creatively problem solving as a consumer and creator of knowledge).

Defining Digital Literacy

To define digital literacy, two key attributes of digital literacy emerged from the data as identified by the study participants. The first attribute is being able to use digital technologies. While such an initial understanding of digital literacy is related to Gilster's (1997) preliminary introduction to the concept of digital literacy, it echoes Bawden's (2008) broad elaboration of digital literacy as literacy in the digital age, where importance is placed on the usage or application of the digital technology to carry out traditional literacy tasks such as reading and writing.

In understanding digital literacy as being able to use digital technologies in my study, participants' perception of digital literacy was operational in nature (i.e., using Google Jamboard). Their perceptions were focused more on computer literacy (IT or ICT literacy) as the operational skills needed to use IT systems (Bawden & Robinson, 2015). Gilster's (1997) conceptualization of digital literacy, while inclusive of the knowledge to use digital technologies, expands the focus beyond technical skills. Participants in the study tended to speak of digital literacy in reference to digital tools and technologies. For instance, in my study an instructor explained how "digital literacy is knowing which tools you need for your goals, and in these

cases, it was our learning goals"; another added how digital literacy was "simply a tool." Based on participants' interchangeable understandings of digital literacy as digital tools, it is evident that participants' understanding of digital literacy did not differentiate it from that of being the use of digital tools.

The second attribute of digital literacy identified from the data is that of purposefulness. The study participants placed emphasis on using digital tools as well as on paying careful attention to *how* and *why* digital tools are used to support learning or the learning task at hand. The instructors and administrator shared examples such as those pertaining to the authentic usage of digital technologies (i.e., SMART Board® interactive displays), and intentionally using digital technologies. In their definition of digital literacy, Hague and Payton (2010) noted that it was important to understand how and when digital technologies can be most effectively used to support specific processes (i.e., collaboration).

Civic considerations (i.e., ethical or responsible behaviours when using digital technologies) were also included by participants in using digital technologies in reference to how and why digital technologies are used in a given context. For example, issues regarding power relationships (i.e., who has access to and benefits from digital technology) were mentioned by instructors, who also mentioned responsible digital citizenship and behaviour. This aligns with the inclusive social aspect of digital literacy found in the review of the literature. For example, in Eshet-Alkalai's (2004) reference to the social-emotional likewise makes reference to behaving in a safe and appropriate manner online. Other scholars such as Ng (2012) have also brought attention to "acting responsibly" (p. 53) in social networks; and Belshaw (2011) recognized the civic component as being an essential, key characteristic of digital literacy.

The definition of digital literacy for this study is that it involves using digital technology to communicate, comprehend, and critique digital texts and content with responsible digital citizenship to creatively problem-solve as a consumer and creator of knowledge (Belshaw, 2011; Martin & Grudziecki, 2006; Ng, 2012). While the study participants did speak to some of these definitional elements in their understanding of digital literacy (i.e., using digital technologies; responsible digital citizenship), the other elements of digital literacy were missing. For example, critiquing digital texts is an element important for digital literacy (Ng, 2012). With the plethora of digital sources and resources available, a digitally literate person needs to think critically about information to identify whether it is credible and authentic (Belshaw, 2011; Ng, 2012). Reference to critiquing digital texts were not evident from the data from the administrator and instructor participants in my study.

Another key element from the definition of digital literacy for this study is that of creatively problem solving as a consumer and creator of knowledge (Martin & Grudziecki, 2006). Creative problem-solving is increasingly important for being digitally literate as complex problems in the world today require innovative thinking and collaboration to address them. It is also why creating and not only consuming knowledge is needed (Belshaw, 2011; Buchanan, 1992). For example, learning how to read and understand the code of a programming language (e.g., JavaScript, Python), is a part of consuming knowledge. Using that consumed knowledge to write new code (i.e., to program a robot to help solve a complex problem), for instance, creates knowledge in the form of a product (i.e., programed robot). Participants in my study focused on defining digital literacy as using digital tools and being purposeful with the use of digital technology in teaching and learning. From the data, the specific element of creatively problem-solving as a consumer and creator of knowledge was not apparent.

Developing Digital Literacy in a Teacher Education Program

The review of the literature on the development of pre-service teachers' digital literacy revealed several perspectives as articulated by List (2019). In addition to the commonly found skill-based, digital native, and sociocultural perspectives on digital literacy, List's (2019) study also identified that pre-service teachers' conception of digital literacy can be: autonomously-developed, technology-driven, or project-based. The autonomous perspective is that pre-service teachers develop digital literacy independently with limited support from instructors (List, 2019). Many pre-service teachers have acquired digital literacy through their "own independent exploration of various technological tools" (List, 2019, p. 152), having been surrounded by digital technologies throughout their lives. The technology-driven perspective in List's (2019) study found that pre-service teachers have developed digital literacy through having access to and using digital technology and that they develop their digital literacy through "the creation of a tangible product or outcome" (List, 2019, p. 153).

Analysis of my study's findings on pre-service teachers' digital literacy development based on the administrator's and instructors' perspectives were complimentary to those found by List (2019). For example, the variations in contextual demands towards digital literacy can be similarly reflected in the effects of the embedded approach of digital literacy development in the teacher education program. The administrator explained that this approach was taken in effort to speak to the quick, ongoing shifts in digital literacy over time. In agreement, the instructors emphasized multiple times in the focus groups that the course is not focused on digital literacy, but on processes of thinking in designerly ways. In review of the course outline, there was no specific learning intentions (objectives) and/or assessment focused on digital literacy. Rather,

from the interview data it was noted that digital literacy was an embedded component in the course.

List (2019) investigated pre-service teachers' perspectives on digital literacy, whereas with my study the perspectives were from instructors' and administrator's points of view. Instructors spoke of how pre-service teachers' digital literacy development in a teacher education program occurs in two ways: planned and responsive. First, according to the participants, planned approaches referred to elements such as course learning intentions and lesson planning. Instructors spoke about incorporating digital technologies into their lesson planning to foster students' collaboration as part of meeting the course learning intentions since the design of the course is "inherently collaborative." For example, one instructor expressed how they were "searching out online collaborative tools that were accessible" such as "Google Jamboard as a way of tracking [students'] thinking and ideas." Second, responsive approaches to digital literacy development referred to the adjustments that instructors would make on an ongoing basis to pre-service students and needed within the course as they emerged. For example, instructors discussed how pre-service teachers' accessibility to digital technologies required adjustments to their expected lesson plans. For instance, when choosing which digital software programs, instructors found that they couldn't "expect them [pre-service teachers] to have the latest laptop for online learning"; instead, they "just had to work with the students in [their] class." In response to the sudden shift to online learning due to the COVID-19 pandemic, instructors had to work with what "everybody can handle" so that "no one gets overwhelmed."

List's (2019) project-based perspective aligned with the administrator's expression of how digital technologies are used in a way that is authentic to the learning task. The administrator in my study spoke of how technology is not added on solely for its own sake, but

purposefully for the learning task. Instructors furthered this point in how they defined a key attribute of digital technologies as purposeful integration. Although participants viewed purposefulness as important for developing pre-service teachers' digital literacy, not many explicit examples were provided demonstrating how they implemented purposeful used digital technologies for the development of digital literacy.

This study occurred in one teacher education program in western Canada. It is noted that the *Learning and Technology Policy Framework* (Alberta Government, 2013) and/ or ICT K-12 (Alberta Learning, 2016) curriculum were not referenced by the study participants. It is important that instructors in teacher education program be familiar with the provincial frameworks and mandated curriculum associated with digital literacy and technologies when preparing pre-service teachers for K-12 classrooms.

Factors that Influence Pre-service Teachers' Digital Literacy Development

From the data, two factors were identified that influence pre-service teachers' digital literacy development in a teacher education program. First, risk-taking (or openness) was identified by participants for developing pre-service teachers' digital literacy. As noted by the instructors and the administrator in the study, instructors and pre-service teachers need to have the willingness to explore together with digital technologies in the course that fosters an openness towards using technologies and supporting digital literacy development. McGarr and McDonagh (2019) noted that "one's openness to new digital technologies" (p. 30) is instrumental in pre-service teachers' digital literacy development.

Second, modeling was identified by all instructors as being central for pre-service teachers' digital literacy development. Throughout the course lessons and assignments, instructors themselves each used digital technologies authentically and pedagogically. For all of

the instructors, modeling was a way by which they could show pre-service teachers how to teach with digital technologies and how they could in turn proceed to teach digital literacy to their future students. For example, one instructor shared how they had to pay very careful attention to what they were modeling to their students, and how they "model the use of a digital platform within that digital environment." In effort to portray authenticity, another instructor shared their reflective thoughts on how they were "modelling [their] own growth in front of [their] students" in regard to teaching and learning with digital technologies (i.e., Zoom).

Similarly, in their study, Røkenes and Krumsvik (2014) found modeling to be an important approach for supporting pre-service teachers' digital literacy development. The modeling approach refers to teacher educators, mentors, and peers promoting specific practices and views through intentional displays of teaching behaviour (Røkenes & Krumsvik, 2014). They reported that instructors modeling the purposeful integration of digital technologies within meaningful learning activities was found to be effective for pre-service teachers' learning. Specifically, the "modeling needs to involve student teachers getting hands-on experience with the technologies" (Røkenes & Krumsvik, 2014, p. 263) to be effective. According to Hauck and Kurek's (2017) review of the literature on digital literacy in teacher education, instructors should provide pre-service teachers more opportunities to develop digital literacy through modeling.

Røkenes and Krumsvik's (2014) also identified an assessment approach as being important for supporting pre-service teachers' digital literacy development. They used the term *assessment* as either formative or summative feedback given by teachers to their pre-service teachers (Røkenes & Krumsvik, 2014). As evidenced by the course outlines and participants' interview data in my study, there were no assessments related to digital literacy (i.e., learning intentions or objectives). Despite the lack of assessment of digital literacy, participants agreed it

is becoming increasingly important and hence should be addressed more explicitly moving forward. Røkenes and Krumsvik (2014) also pointed out this notion, as it is in "setting explicit expectations" (p. 265) through assessments that becomes effective for supporting pre-service teachers' digital literacy development. Curriculum review and mapping of courses on the program level is useful way for determining learning outcomes (i.e., in regard to digital literacy) and associating them with corresponding courses within the program (Harden, 2001; Lock et al., 2018). According to McGarr and McDonagh (2019), a taxonomy- or hierarchical-type model are approaches that can be used to understand pre-service teachers' digital competence development. Teacher education programs incorporating a taxonomy-type or hierarchical-type model can support the scaffolded progression of digital literacy development throughout the program for pre-service teachers. In teacher education programs, it may be helpful to engage in curriculum mapping to determine where and how digital literacy is integrated in the program and how this information can be communicated to both pre-service teacher and faculty (instructors) (Kaupp & Frank, 2014; McGarr & McDonagh, 2019).

Summary

Considerations need to be made for pre-service teachers' digital literacy development in a teacher education program. Alongside the literature, administrator and instructor perspectives on pre-service teachers' digital literacy development indicated factors that are important to consider. Factors such as instructors' openness (or risk-taking) and modeling the usage of digital technologies in their course were identified as important for pre-service teachers' digital literacy development. Likewise, learning tasks and assessments can provide instructors and the teacher education program feedback on digital literacy development.

Instructors need to have an understanding of digital literacy as they design authentic and embedded learning tasks to meet the learning outcomes. Within teacher education programs, there is a need to consider setting program goals for digital literacy development and implement professional development supports for instructors.

Conceptual Framework

Based on the findings from my study and evidence gleaned from relevant literature, Figure 1 is a conceptual framework designed to show factors that influence the development of pre-service teachers' digital literacy in a teacher education program. The foundation of this conceptual framework is based on the theoretical underpinning of social constructivism. Social constructivism is present in instructors and pre-service teachers communicating and interacting with each other to collaborate and complete learning tasks in their courses, which is enabled through the integration of digital technologies. Pre-service teachers co-construct knowledge of digital literacy as they engage in social interactions while using digital technologies in their learning. As instructors create authentic learning tasks fostering digital literacy for pre-service teachers, real-world contexts of social interactions are embedded.

In teacher education programs, consideration needs to be given to digital literacy. This may be articulated as part of the goals for the program which then influences course level outcomes. If digital literacy development is a key element of the program, then instructors need to design learning opportunities that foster this literacy development. This may need to start with instructors having a common understanding of digital literacy. To help instructors in

Figure 1

Conceptual Framework for Developing Pre-service Teachers' Digital Literacy in a Teacher

Education Program
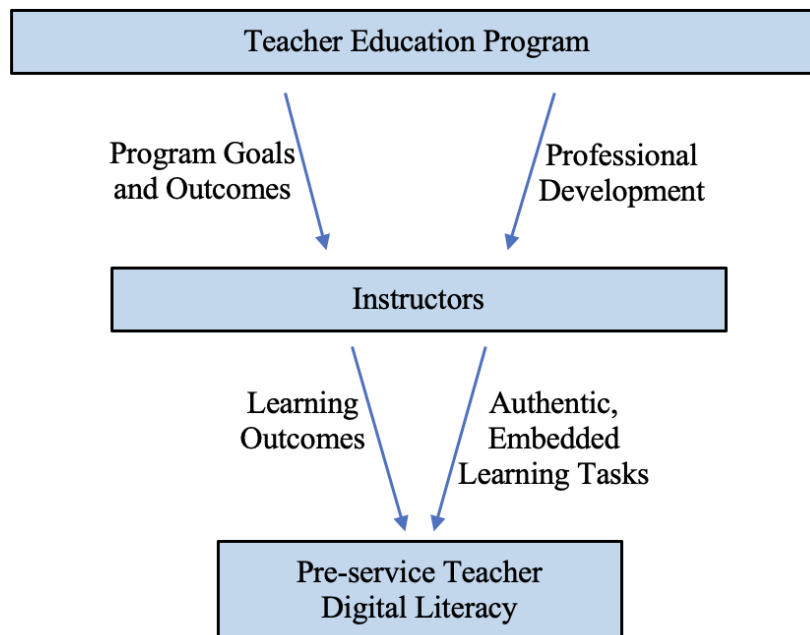
understanding the phenomenon and/or designing learning to foster digital literacy development, professional development may need to be available. The professional development may take various forms such as: learning activities, a series of scaffolded sessions, or online learning modules.

Based on understanding the digital literacy goal(s) for the program and how they are to be integrated into courses, instructors will then design and assess authentic learning tasks that are linked to digital literacy development for pre-service teachers in the courses they teach. When instructors design and facilitate embedded digital literacy learning tasks in their courses, pre-

service teachers will have learning experiences that will foster the development of their digital literacy.

Chapter Summary

In this chapter, I discussed the findings in relation to the literature to address my research question. From this study's results, it is evident that digital literacy should be authentically embedded in teacher education programs. It needs to be supported in program implementation of learning outcomes and alongside assessment strategies within courses. Further, instructor professional development needs to be provided to support the development of a common understanding of digital literacy and how it can be integrated in courses and modelled for pre-service teachers to develop their digital literacy.

In the final chapter, I will provide a summary of this research study, discuss the implications for practice, and provide recommendations for future research.

CHAPTER SIX: RECOMMENDATIONS AND CONCLUSION

This chapter comprises three sections. First, a summary of the research study is provided. Second, implications for practice are discussed for teacher education programs, instructors, and pre-service teachers, along with subsequent recommendations for future research. Third, this chapter finishes with a conclusion.

Summary of the Study

This exploratory case study investigated administrator and instructors' perspectives on how pre-service teachers develop their digital literacy within a Design-based Thinking course in a teacher education program. The individual interview with the program administrator (n=1) and focus group interviews with the course instructors (n=5) were designed to gain a greater understanding of how the participants defined digital literacy and what factors they identified as influencing pre-service teachers' digital literacy development within the program.

The following four key factors were considered important for pre-service teachers' digital literacy development in a teacher education program. First, instructors' openness (or risk-taking) and modeling the usage of digital technologies in their courses are important for pre-service teachers being encouraged to use digital technologies. Second, learning tasks and assessments provide opportunities for feedback in support of pre-service teachers' digital literacy development. Third, teacher education programs need to establish program goals that help to foster digital literacy development, as well as provide professional development to support instructors in designing and facilitating the development of digital literacy. Fourth, instructors need to have an understanding of digital literacy so they can design authentic and embedded learning tasks for pre-service teachers in their courses in support of meeting the program goals focused on digital literacy development.

Successes and Challenges

The research study was successful in that participants included a program administrator and instructors, which provided multiple perspectives for examining the phenomenon of pre-service teachers' digital literacy development. Multiple sources of data were also used (i.e., semi-structured individual interview, focus group interviews, and documents), which enabled a deeper exploration of the phenomenon. Further, the study was conducted in a timely manner.

Two challenges occurred in conducting the study. First, there was limited participation in the study. Only one administrator and five instructors participated, while no pre-service teachers volunteered to participate in the study. A second challenge was that this study occurred during the COVID-19 pandemic. As such, this was the first time the Design-based Thinking course was taught online.

Implications for Practice

From this research study, there are implications for practice with regard to teacher education programs that need to be addressed on the following three levels: teacher education program, instructor, and pre-service teacher.

First, for digital literacy to be authentically embedded in courses and a teacher education program, it is important it is embedded in the program goals. Teacher education programs need to determine how digital literacy is being embedded in the program and how it is woven across courses (Harden, 2001; Kaupp & Frank, 2014). From the program goals, digital literacy then needs to be taken up in the learning outcomes and learning tasks.

Second, instructors need to have a common understanding of digital literacy and how it can be integrated in courses within the teacher education program. Professional development

opportunities need to be provided to instructors to support their understanding of digital literacy and how to design, facilitate, and assess digital literacy development in their courses.

Third, digital literacy development needs to be embedded in learning experiences by intentional design. It is through the instructors' design and facilitation of learning tasks that pre-service teachers have experiences to develop their own digital literacy, which in turn supports their teaching practice in their future classrooms.

Directions for Future Research

Based on my study, I present four areas for future research. First, it is important to examine how and where digital literacy is taken up in a program. To examine the linkages and alignment, the use of a curriculum mapping of digital literacy development in a teacher education program is needed. A study can investigate digital literacy development through curriculum mapping of program goals, learning outcomes, teaching activities, and assessments within a teacher education program. Questions to guide this inquiry may include:

- From curriculum mapping, where are the opportunities for digital literacy development in a teacher education program?

- Based on the mapping, how can learning opportunities better support the development of digital literacy?

- What kinds of resources are needed to foster digital literacy integration across courses within a teacher education program?

Data for this study may include mixed methods, gathered from interviews, documents, and surveys with administrators and instructors.

Second, another area is professional development for instructors. Future research can investigate the nature and degree of professional development needed to support instructors in designing and facilitating learning that fosters digital literacy development. The following are examples of research questions to guide the inquiry:

- How do professional development activities support instructors' digital literacy development?

- In what ways do professional development activities influence instructors' understanding of digital literacy in a teacher education program?

- How can professional development activities support instructors' design of learning tasks and assessments for pre-service teachers' digital literacy development in a teacher education program?

This study can be conducted using design-based research (DBR) where a series of professional development activities can be developed and refined through iterations to support the development of digital literacy. Multiple data sources such as pre-and post-interviews, surveys with instructors, and document analysis of digital literacy documents can be used for the inquiry.

Third, it is important to investigate pre-service teacher perspectives of their own digital literacy development when enrolled in a teacher education program. My study sought to explore pre-service teachers' digital literacy, but due to only instructor and administrator participation, pre-service teachers' perspectives were not provided. For further research, it is important to explore pre-service teachers' understanding of their digital literacy and how they develop this literacy through their teacher education program. Proposed research questions could be:

- How do pre-service teachers view their digital literacy development within a teacher education program?

- In what ways are pre-service teachers developing their digital literacy through their courses?

- What role do pre-service teachers view their teacher education program in developing their digital literacy?

For the study, data can be collected from surveys and semi- structured interviews and be analyzed for themes to further inform instructors and teacher education programs on how to support their digital literacy development.

Fourth, my study was conducted during the COVID-19 pandemic where the courses were taught online. An area for future research is investigating the impacts of online teaching and learning on developing pre-service teachers' digital literacy. A research question for this inquiry could be:

- How does learning online impact pre-service teachers' development of digital literacy?

- What kinds of factors are important for developing pre-service teachers' digital literacy in an online learning environment?

Interviews and focus groups with administrators, instructors, and pre-service teachers can be used for the data collection. The data can then be thematically analyzed.

Conclusion

The purpose of my study was to investigate the phenomenon of pre-service teachers'

digital literacy development within a teacher education program. The pervasiveness of digital

technologies is ever more prevalent in every aspect of daily life (Blum-Ross et al., 2020),

including in teaching and learning. Teaching and learning today increasingly requires digital

literacy development, and teacher education programs are recognizing the need to respond to this

greater necessity for pre-service teachers (Daniels et al., 2020). Developing pre-service teachers'

digital literacy in a teacher education program requires it to be explicit in program goals and

learning outcomes. Professional development supports and resources are needed for instructors

to help foster an understanding of digital literacy and facilitate its development in their courses.

In fostering the development of digital literacy with pre-service teachers, teacher education

programs need to be explicit in how it is embedded in the program, as well as provide

professional development support for instructors in how they teach and model digital literacy in

courses. Through the fostering of digital literacy development in teacher education programs,

pre-service teachers may better integrate digital literacy in their teaching practice within their

future classrooms.

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APPENDIX

Appendix A - Sample Interview Questions for Instructor Focus Groups

INSTRUCTOR FOCUS GROUP INTERVIEW QUESTIONS

Thank you for participating in this study.

With the pervasiveness of digital technologies, it is increasingly important to develop pre-service teachers' digital literacy to prepare their future students for the digital realities of life.

This research is investigating digital literacy within a design-thinking course in a teacher education program with the research question: How do pre-service teachers develop digital literacy within a design-thinking course in a teacher preparation program?

Your participation in this interview will be used to deepen understanding of pre-service teachers' digital literacy development and ways of supporting their development.

Everyone will have an opportunity to share and engage in conversation. We hope that we can spark ideas off of each other as we converse. The focus group is designed to be 45 to 60 minutes in length. I have 14 questions that I am going to ask within three sections.

As noted in the consent form, this focus group interview will be recorded. As a reminder, information shared in this focus group is to remain confidential. Is it okay with you that I now start the recording as we begin the interview?

Part 1: Demographic Information – Asked for each participant.
1. How long have you been teaching as a sessional instructor?
2. How long have you been teaching the EDUC 546 Design Thinking Course?

3. This year, which specialization are you teaching?

Part 2: Digital Literacy
1. How do you define literacy?
2. What are the key attributes or characteristics of digital literacy?

      (Note to Researcher: One definition of digital literacy is that it is about using digital technology to communicate, comprehend, and critique digital texts and content with responsible digital citizenship to creatively problem-solve as a consumer and creator of knowledge (Belshaw, 2011; Martin & Grudziecki, 2006; Ng, 2012).

3. Describe to me what digital literacy looks like in your Design Thinking course. Please provide an example.

Part 3: Design-Thinking
1. Tell me about how pre-service teachers experience digital literacy within your Design Thinking course?
   a) Please provide an example
   b) What kinds of activities would be involved?
2. How are digital technologies used in this course that foster digital literacy?
3. What are the strengths with regards to using digital technologies in developing digital literacy?
4. What recommendations can you offer in relation to factors or conditions that are important for developing pre-service teachers' digital literacy within a Design Thinking course?
   a) How about such recommendations related to the B.Ed. program?
5. What role as an instructor of this course do you have in fostering digital literacy?
   a) What are some strategies you have found to be successful for this?
6. What recommendations can you offer in how to better develop digital literacy in this course and in the program?

Wrap-up

1. Is there anything else you would like to share with me in regard to this study?

Thank you.