Understanding Preservice Teachers' Use of Digital Technology to Support Their Learning & Teaching

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Abstract

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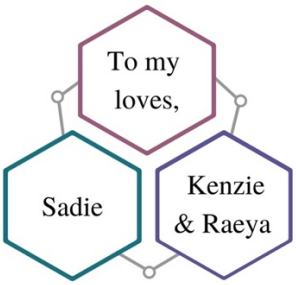
Teacher education programs recognize the impact of technology's rise on the process of learning to teach. Prior studies have examined both the effectiveness of specific digital tools and contextual factors in shaping preservice teachers' technology use in classrooms (focusing largely on teacher educators' technology selections, the locations and durations of tool use, and learning outcomes); but little is known about preservice teachers' own technology preferences or the unique ways they leverage digital tools to support their learning in and across teacher education program settings and to enhance their students' learning. I therefore employed a sociocultural approach to study teacher learning: a year-long qualitative investigation, with interview, observation, survey, and visually-based data, designed to discover how a sample of six preservice teachers from a secondary teacher education program used established digital

practices and new technical skills to develop relationships, acquire knowledge, and gain practical experience.

The six participants brought diverse personal histories of technology use into their teacher education program influenced by family, friends, and colleagues who helped shape early technology use behaviors, which in turn affected how they used technologies to support their academic needs and their students' learning. In selecting and using what they perceived to be helpful and appropriate technology during their teacher education program, the participants negotiated both external factors (availability of technology, participation expectations, and assignment parameters) and internal factors (personal values, goals, and preferences). The preservice teachers developed novel sequences of devices and applications to achieve complex goals and these sequences became familiar routines to support ongoing learning. The preservice teachers exercised agency to implement new tools (and integrate them with preexisting tools in their environments) that further empowered them to search for relevant information, engage with course content, connect with peers and mentors, create structures for planning and teaching, and respond effectively to students.

My findings should help teacher education programs and teacher educators understand the influences of preservice teachers' unique prior histories with digital technologies so that they can better support these future teachers in identifying and adopting the technologies they require to effectively engage in both learning and teaching.

Dedication



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PART I

CHAPTER 1

Dissertation Introduction

"I will learn it—either at Cascade University, or online."

- Chloe, a science preservice teacher

This succinct quote from one of the participants discussed in this dissertation highlights the relevancy of technology in preservice teacher learning. I selected this quote from an interview in which Chloe discusses a frustrating situation during her student teaching placement. She has a strong desire to learn how to use the Smart Board in her classroom, and neither her mentor teacher nor the technology center for her teacher education program (TEP) can support her in this endeavor. Unable to find the guidance she was looking for, Chloe persists in using digital technologies, namely her laptop and the Internet, to teach herself how to use the Smart Board to support her teaching practice. Equipped with recently acquired knowledge from YouTube videos, Chloe arrives at her school early the following day to practice using the novel tool. Chloe's drive to achieve her goal results in her successfully learning how to use the Smart Board and integrating it into her practice as a student teacher. This learning episode offers one of many examples of how preservice teachers can leverage digital technology to support their learning as future teachers.

In my dissertation, I use a biographical approach to study how a specific group of preservice teachers use technology. I value preservice teachers' digital lives as relevant elements of their prior histories that they can leverage when learning to teach. My year-long qualitative

study investigates how preservice teachers use their established digital practices and develop new technical skills to mediate their actions and thinking in and across the settings of their homes, university courses, and student teaching placements. The findings of this dissertation contribute to what researchers and teacher educators know about the diverse compositions of a group of preservice teachers' digital lives and how they weave together different electronic devices, forms of media, and digital practices to support their personalized learning trajectories. My data analysis sheds light on how these preservice teachers identify gaps in their knowledge and experiences and use different forms of technology to support their learning needs.

In this introductory chapter, I begin by describing what we know about preservice teacher learning with technology. Next, I identify gaps in our knowledge about how preservice teachers use technology to support their learning. I use a graphic to illustrate how my dissertation provides insight into these gaps, and then I introduce the context of my study and present my research questions. After introducing my study, I draw on research from the fields of learning sciences and technology and media studies to offer a contemporary approach to teaching and learning with technology that undergirds this dissertation. I conclude this introduction by outlining and describing the remaining dissertation chapters.

Digital Technology in Teacher Education Programs

Over the past decade, the field of teacher education has seen a rise in digital technology used in TEPs. The many stakeholders in preservice teacher learning are driving this increase in technology use, as they recognize its impacts on the profession of teaching and on the process of learning to teach. Teacher educators are grappling with the growing digitization of teachers' work and with how to best prepare future teachers for this new reality (Starkey & Starkey, 2020). Teacher educators are also exploring how to use digital technologies to support the process of

learning to teach (Tondeur et al., 2012) and how digital technology is changing what counts as text and inquiry in their subject areas (Mirra, 2020). There is also a growing consensus that not only does there need to be more digital technology in teacher education, but it needs to be integrated across the contexts of TEPs, rather than siloed into a single educational technology course (Office of Educational Technology, 2017). By integrating digital technology into and across coursework and field placements, preservice teachers can use it in personalized ways to support their learning trajectories over time and across settings.

Digital Technology for Preservice Teacher Learning and Teaching

Researchers study how preservice teachers use technology to learn specific concepts or dispositions during their coursework. These studies tend to look at the effectiveness of one or more digital tools in supporting preservice teachers in gaining knowledge specific to the practice of teaching (e.g., Anson et al., 2016). In addition, researchers study how preservice teachers learn to teach with technology. This strand of research explores influential internal factors (e.g., preservice teachers' beliefs) and external factors (e.g., teacher educators' approaches) present in university and school contexts (e.g., Admiraal et al., 2017). Common to all of this research is the overarching notion that using technology in formal learning settings is a complex endeavor. Teaching with technology can be impacted by broad influences like district and school access to hardware and software and leadership support, as well as more localized factors such as effective role models and authentic planning, teaching, and feedback experiences (Tondeur et al., 2016). Thus, to understand the multiple and interconnected influences that shape what, where, and how preservice teachers learn and teach with technology, it is important to adopt an ecological perspective.

Where Are the Gaps in Our Knowledge?

Much of the research on preservice teacher learning and technology takes a top-down approach as it is designed by teacher educators and researchers, who explore the pedagogical value of including devices and digital media in preservice teacher learning. While there is great value in these empirical studies, I argue that there are gaps in the body of research that this dissertation can begin to fill. My main concern is that much of what we know about preservice teacher learning with technology focuses on specific technologies selected by teacher educators and researchers. This means that we know relatively little about how preservice teachers use technology as a tool on their own terms to support their learning. I argue below that a more biographical approach focusing on preservice teachers' prior histories can provide a more comprehensive understanding of their preferences and routines for using technology to support their learning as future teachers.

A Description of Figure 1

Figure 1 is a graphic I created to visualize the gaps in our knowledge about preservice teacher learning with technology that my study aims to help fill. The six main components of established research are in the smaller bold hexagons in the center of the graphic. They are as follows: digital technology selection, focus of learning, predetermined outcome/product, isolated learning episodes, individual and peer learning opportunities, and classroom-based experiences. My dissertation's contributions are represented in text placed outside the bold hexagons.

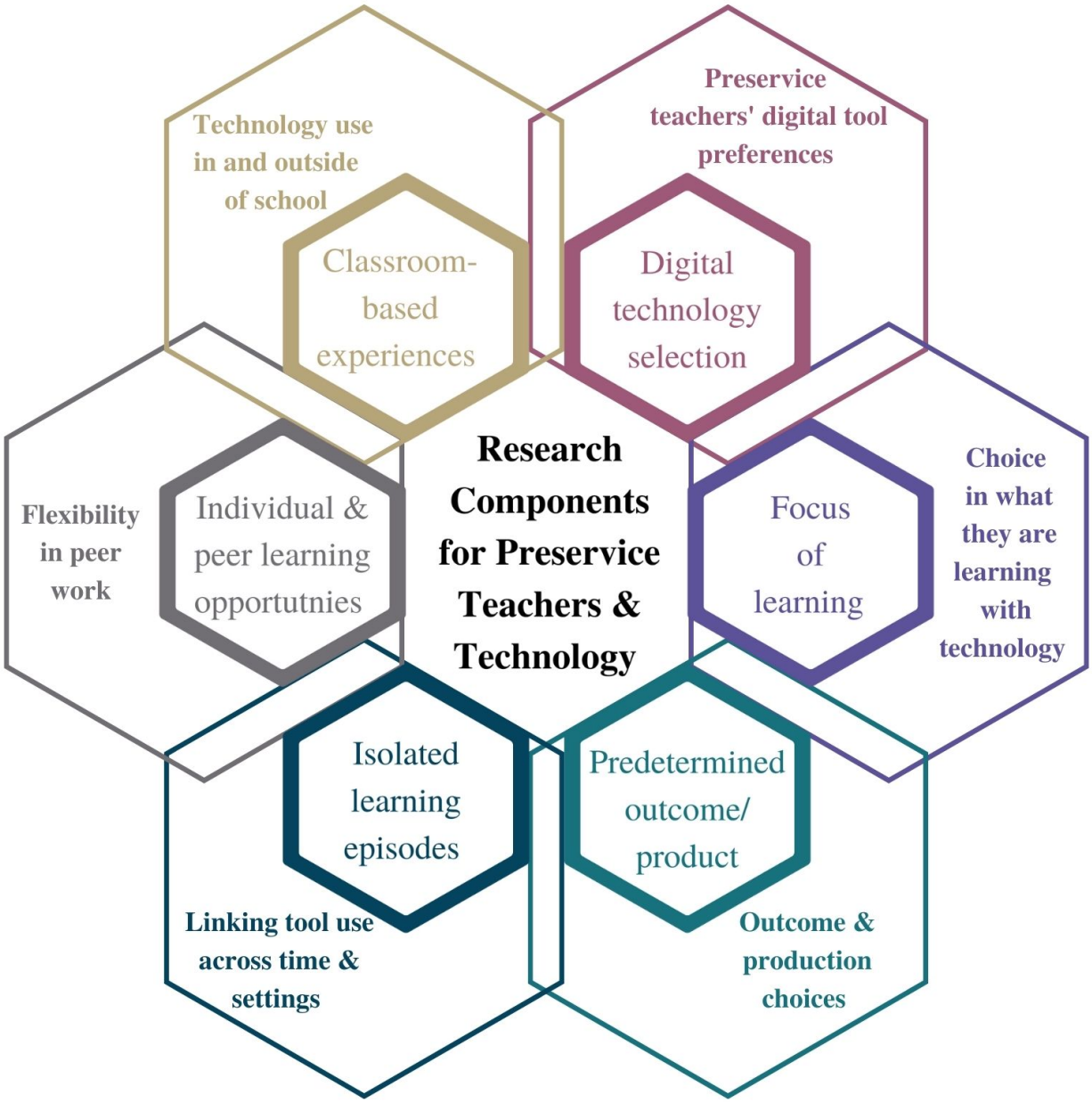


Figure 1. How my dissertation fills gaps in preservice teacher learning with technology.

Beginning at the upper right corner, the **maroon** hexagon in Figure 1 signifies that in most studies, a majority of teacher educators choose one or two specific technologies and test their effectiveness for preservice teacher learning. While this is a sound practice in many cases, preservice teachers have little say about which devices and applications they want to use in their learning. As a result, we do not know enough about the digital tools and practices preservice teachers prefer to use in TEPs. But not only are we uncertain about their preferences for digital technologies; we also know little about how they weave together multiple devices and media to support their learning. To address this gap, my dissertation explores the range of digital tools and applications from the preservice teachers' perspectives and includes their uses at home, in transit, with peers, during and after class, with mentor teachers, and while teaching.

Moving clockwise around the graphic, the **lavender** and **teal** hexagons signify that in most studies, teacher educators choose what content, dispositions, or skills they want preservice teachers to learn with technology. Although some espouse the importance of a constructivist learning pedagogy in their methodologies, the artifacts that preservice teachers construct are generally decided in advance by researchers and teacher educators. Consequently, preservice teachers are not given much opportunity to exercise agency in how they use technology in their learning. As part of the research presented in this dissertation, I designed an assignment for the participants to complete in their educational technology class that would address this gap, allowing for creativity and choice. I also collected data across preservice teachers' foundations, methods, and supporting courses to examine various tool and artifact choices.

Moving to the bottom left corner, the **dark turquoise** hexagon shows the technology-based learning outcomes for preservice teachers, which are typically isolated in a specific class, class period, or assignment. This may limit our understanding of how preservice teachers use

digital tools across assignments and courses. While it is important to study the affordances and constraints of particular tools in specific instances, less is known about how preservice teachers may combine multiple technologies in their learning, and how these uses can span different courses, content areas, time periods, and settings. Over the course of my research, I observed and interviewed the participants once per quarter during their year-long TEP and considered both in-the-moment and long-term device and application use.

Continuing around to the left side, the **gray** hexagon in Figure 1 notes that teacher educators typically direct preservice teachers to work individually or in small groups when studying technology use. While technology-aided learning with others has its benefits, this dissertation accounts for preservice teachers choosing who they work with during and after class to complete assignments.

Finally, as signified by the **gold** hexagon, existing studies tend to investigate digital technologies that are classroom-based. This means that this research mostly studies how preservice teachers use digital tools while in the classroom and typically use them to complete assignments. I argue that this focus does not account for the devices, media, and practices that preservice teachers cultivate outside of school to support their learning in school. I therefore aim to account for the devices and media in preservice teachers' lives both in and outside of their TEPs.

By considering all six of these components, my research takes a comprehensive and biographical approach to studying preservice teacher learning. I explore how a group of preservice teachers' digital lives before and during their TEP connect to their prior histories and current beliefs—elements that can be used to support their individual development as future

teachers. Furthermore, this dissertation offers insight into how preservice teachers identify gaps in their learning and use different forms of technology to support their personal learning needs.

To that end, I designed a year-long qualitative study with quarterly data collection procedures to study six preservice teachers with varying degrees of digital skills and dispositions for using technology. These three research questions are addressed throughout the dissertation:

Research Question 1: What digital technologies do the preservice teachers use before and during their teacher education program?

Research Question 2: How do the preservice teachers use digital technologies to support their participation in the different settings of their teacher education program?

Research Question 3: In what ways do the preservice teachers exercise agency in using digital technologies in the different settings of their teacher education program?

Background and Definitions

The Rise of Digital Technology in Daily Life

In this dissertation, digital technology includes but is not limited to, hardware such as electronic devices (e.g., laptops, mobile phones, tablets, projectors, etc.) and software applications (e.g., media players, mobile phone apps, presentations, spreadsheets, social media platforms, web browsers, video games, etc.). Research shows that over the past two decades a majority of people have been using increasing amounts of digital technology in their lives. A snapshot of device ownership in the United States of America shows that almost 75% of adults

now own a laptop or desktop computer (Hiltin & Pew Research Center, 2018); 95% of teenagers own or can obtain access to a smartphone and the percentage of older adults with smartphones continues to rise, currently at 42% (Vogels & Pew Research Center, 2019). Just as device ownership and access grow, people are increasing their time on the Internet and social media. During the COVID-19 pandemic, around 85% of adults used the Internet daily (Perrin & Atske & Pew Research Center, 2021). Interestingly, significant percentages of young people and adults report being continually online for entertainment purposes, news consumption, and to connect with others (Pew Research Center, 2021). While these statistics provide a glimpse into the strong usage of digital technology among the American public, they do not capture the complexity of people's digital lives—a topic that researchers have explored using more ethnographic approaches.

The proliferation of digital technologies in contemporary life creates opportunities for researchers to study the design of devices and digital media and how these products mediate individual participation in social settings. It is vital that technologies are not seen as neutral tools for use (Winner, 1980; Strate, 2012), rather they are tools created by people with biases and life experiences that can impact their design decisions (Wachter-Boettcher, 2017). Thus, taking a critical stance when evaluating the role of devices and digital media on society's norms and our thinking is warranted (Hobbs, 2021).

As tools of mediation, digital technologies foster interactions and practices between people existing in and across cultural and institutional spaces (Fishman & Dede, 2016). While some argue that digital technologies and digital media are tools that amplify existing practices, such as engaging in political discourse (Agre, 2002) and global development (Toyama, 2011), others contend that digital technologies may hinder learning in educational settings (Amador et

al., 2016; Alvarez, Bower, de Freitas, Gregory, 2016). Conversely, extant research indicates that digital technologies and digital media have the potential to transform methods of participation in different social contexts (Collins & Halverson, 2016; Ito et al., 2013). Digital technology provides opportunities to redefine what it means to be literate in the Digital Age. Seen in this way, individuals leverage digital tools to create novel multimodal methods of communication in digital and face-to-face interactions (Lankshear & Knobel, 2008).

Digital Technologies Mediating Participation Within and Across Learning Contexts

Digital technologies (comprising devices and media) are not transformative through their existence alone (Toyama, 2011). Instead, their affordances and constraints emerge through use within and across social contexts. Recent research on students indicates that they can use digital technologies to develop digitally-based practices that forge connections between the different contexts of their lives (Barron, 2004; Ito et al., 2010; Kumpulainen & Mikkola, 2016). Technology and social media scholar danah boyd[1] argues that "contemporary youth are growing up in a cultural setting in which many aspects of their lives will be mediated by technology, and many of their experiences and opportunities will be shaped by their engagement with technology" (boyd, 2014, p.26). In this way, digital practices are increasingly embedded into students' lives and may aid in forging links between their families, peers, communities, and school settings (Erstad, 2012). Other researchers explore how technologies impact peer relationships in terms of connection, vulnerability, and constant accessibility (Gardner & Davis, 2013).

My own understanding of digital practices is informed by Pink et al.'s (2014) notion that technology-based practices are embedded into our everyday lives and are part of our routines. I

[1] danah boyd publishes her name using all lowercase letters.

also look to Henry Jenkin's (2009) definition of participatory practices. He suggests that digitally mediated practices create "relatively low barriers to artistic expression of civic engagement, strong support for creating and sharing creations, and some type of informal membership whereby experienced participants pass along knowledge to novices" (p. 4). This definition includes digital participatory practices with affinity groups on social media, and can include creating content and collaborative problem solving on Internet sites. Furthermore, digital practices can include information and communication technology (ICT) skills like identifying, gathering, evaluating, and presenting online information (McLoughlin, 2006). Taken as a whole, I understand students' digital practices to represent an ever-changing repertoire of abilities and dispositions that they use to participate in and across virtual and in-person educational settings.

The integrated nature of digital technologies allows researchers to take a biographical perspective in which students develop personal media ecologies that may include, but are not limited to, their interests, media, practices, and relationships (Horst, Herr-Stephenson & Robinson, 2010). Ito et al. (2010) define a media ecology as "the technological and social context in which young people are consuming, sharing, and producing new media" (p. 27). However, these components do not occur in isolation within an individual's media ecology. Rather, people exert agency through digital technologies to connect learning practices that span formal and informal learning spaces as well as virtual and face-to-face interactions (Barron, 2004; Ertsad, 2012; Kumpulainen & Mikkola, 2016).

New Conceptions of Learning

The interconnected nature of digital technologies within learners' lives creates a shift in *how*, *where*, and *when* learning occurs. No longer can we divide learning into something that happens in formal and informal spaces (Erstad, 2012). Instead, we can take a "learning lives

approach" (p. 28), which positions learning as occurring within and across students' learning practices and settings. Accordingly, Erstad (2012) suggests that learners have agency to connect the practices and settings of their learning lives using their own digital interest-driven practices. In other words, students have the ability to use their digital practices in unique ways that meet their specific learning needs. Teachers play a central role in acknowledging students' interests and digital practices, and in designing transformative learning opportunities (Baker-Doyle, 2017). Research shows that students can thrive when given the opportunity to engage in learning that ties together personal interests, peer culture, and academic pursuits (Ito et al., 2013; Peppler, 2014).

The aforementioned existing research produces a contemporary view of learning in which learners can use the practices, interests, and relationships formed in their media ecologies to create integrated learning experiences spanning the social contexts of their lives. In this way, learning is no longer relegated to the classroom (Looi et al., 2010). Instead, and as Leander, Phillips, and Taylor (2010) suggest, we need to rethink and challenge traditional locations and conceptions of education. It is possible to reframe classroom environments from static containers of learning into larger, continuously moving webs of people, information, technology, and energy (Leander, Phillips & Taylor, 2010). Learning then becomes an evolving act of participation in different digital and non-digital activities, involving various people and artifacts in face-to-face and virtual spaces (Barron, 2004). This dissertation is concerned with whether and how this conception of learning can be applied to preservice teachers in their TEPs.

Technology In Formal School Spaces

While students have been using digital technologies outside of school for a myriad of interest-driven practices, digital technology has not reached its potential in school settings. In

Garcia's view, "the classrooms and schools today look remarkably like classrooms and schools of the past" (2014, p.6). While teachers tend to take a more teacher-centered view of using technology (Funkhouser & Mouza, 2013), there is great potential for digital technology, including Web 2.0 technologies, to offer students opportunities for creation, connection, and meaningful interactive activities (Greenhow et al., 2009). The inclusion of digital technologies in schools can "shift expectations of expertise and content delivery" (Garcia et al., 2014, p. 6). Digital technologies such as geospatial devices and motion-sensor cameras are being used in educational settings to disrupt the traditional expectations for knowledge creation and learning experiences (Taylor & Silvis, 2017). In addition, educators can use digital technology to alter established classroom roles by becoming co-learners alongside students; and together, they become "co-creators of knowledge" (US Department of Education, 2017). Thus, digital technologies can be used to transform traditional curricula and classrooms into interactive student-centered learning spaces, leveraging practices that activate student voice and knowledge production.

The Impact of Digital Technology in Higher Education Settings

Over the past two decades, there has been an infusion of information and communication technology (ICT) in higher education institutions (Lai, 2011). Students report that the increase of technology in university coursework improves their access to materials and provides more visuals to support their learning (Henderson et al., 2015). While these represent significant gains, others argue that the promise of technology in university settings has not reached its potential in supporting universities as spaces for innovation (Selwyn, 2014). However, there are transformative approaches to integrating technology in university courses: ones that effectively expand the scope of when, where, and how learning occurs. Bell et al. (2019) designed a novel

learning theory course leveraging mobile technologies such as a science-based phone application that allowed students to collect and share data about their site visits around the university community. This example of technology integration into higher education shows great potential for reimagining learning for adult learners in ways that connect to their diverse media ecologies.

Dissertation Overview

This dissertation was borne of my dual interests in preservice teacher learning and in students' digital lives. I believe that research in teacher education and the learning sciences complement each other and are essential to creating a comprehensive approach to researching preservice teacher learning through digital technology. I draw from teacher education research to provide a foundational understanding of how people learn teaching, with a focus on learning in communities with conceptual and practical tools (Grossman et al., 1999; Hammerness et al., 2005). However, I argue that the existing research related to preservice teachers learning with digital technology tends to take a limited view of when, how, and where such learning occurs. I have thus incorporated research from scholars of learning sciences and technology and media studies to provide a more comprehensive and biographical approach to studying the complexity of learning in the Digital Age. Below, I outline the chapters that constitute this dissertation.

Chapter 2. Exploring the Complexity of Preservice Teacher Learning

In this chapter, I begin by introducing four phases of teacher learning that span preservice teachers' careers. I then move into exploring what preservice teachers learn in terms of conceptual knowledge, dispositions, and practices present in university-based courses and fieldwork. Because what one learns is linked to how one learns, I examine the influence of personal histories, considering how preservice teachers learn through mediated participation

within and across multiple communities of practice. Next, I discuss the relevance of tools to distributing knowledge and teaching expertise. I conclude by investigating the role of agency in how teachers become intentional actors in the multiple settings of their program.

Chapter 3. The Three Research Strands of Preservice Teachers and Technology

In this chapter, I examine existing research on preservice teachers and technology. I begin by describing how extant research into preservice teachers and technology can be organized into three distinct categories. First, I explore how preservice teachers' technical knowledge and dispositions are seen as essential factors influencing their use of technology in their teaching. Second, I describe what we know about how preservice teachers use specific digital technologies to learn knowledge and dispositions central to teaching. And third, I outline an ecological model for thinking about the internal and external conditions that shape whether and how preservice teachers use technology in their student teaching placements.

Chapter 4. A Sociocultural Perspective on Preservice Teacher Learning

In this theoretical framework chapter, I weave together specific sociocultural theories of development to present a view of how preservice teachers learn through mediated participation and in the diverse TEP contexts. I begin by offering an overview of the ecological dimensions of learning, and I detail the interconnected nature of the multiple settings in preservice teacher learning, focusing on their historical, cultural, and social dimensions. Next, I explore the concept of 'communities of practice' and argue that preservice teacher learning occurs through action, making meaning, and developing a sense of belonging. I also examine the ways in which

preservice teachers contribute to their communities of practice exercising their agency with mediated, temporal, relational, and transformative dimensions.

Chapter 5. Research Methodology

In this chapter, I describe my methodological design for this dissertation. I begin by situating my study within the traditions of qualitative teacher education studies. I then define the specifics of the study's context, describe how I selected the participants, and detail my data collection procedures. My data collection tools, such as survey and interview questions, are available in the Appendix. I also introduce all six participants in terms of their demographics and self-reported digital lives. I conclude the chapter with information about my data analysis procedures, examples of my codes, and emergent themes that frame my findings chapters.

Chapter 6. The Composition of Preservice Teachers' Digital Lives

In this chapter, I start by analyzing the six participants' digital lives before entering their TEP, paying particular attention to their use of electronic devices and digital media. I discuss my participants in terms of three life phases: (1) childhood and adolescence, (2) emerging adulthood, and (3) as adults entering TEPs. I provide evidence that people such as family, friends, and colleagues can both shape preservice teachers' access to digital technologies and affect how they value and use their devices and media. My evidence suggests that the preservice teachers in this sample have unique and meaningful prior histories with technology that became foundations for various utilizations of technology during their TEP.

Chapter 7. Preservice Teachers and Technology: Negotiations Between Internal and External Factors

This chapter shows how my preservice teachers intentionally use digital technologies to support their participation in university courses and student teaching placements. In these settings, they engage in a range of activities and leverage various digital tools to support their own learning needs such as connecting with peers, searching for information, and creating teaching materials. Although my data shows that participants had similar goals and tasks to complete, they choose and use different devices and programs to achieve these ends. I present evidence suggesting that the participants' choices of digital technologies are linked to routines of technology use they developed prior to the program. I conclude the chapter by detailing the ways in which the study participants use sequences of digital technologies to participate in student teaching placements in terms of co-planning, co-teaching, and content creation. Overall, this chapter suggests that preservice teachers in this sample negotiate their intentions for using technology by drawing on a combination of internal and external factors.

Chapter 8. Preservice Teachers Exercising Agency with Digital Technology

In this chapter, I analyze how the preservice teachers exercise agency in using various technologies. I begin by describing variations in the contextual resources of each setting and how these resources worked to enable or constrain preservice teachers' capacity to act. My data analysis suggests that the preservice teachers navigate the unique dimensions of their courses and placements and exercise agency with technology in two main ways: (1) negotiating with their mentor teachers, and (2) defining goals related to teaching. I describe how the participants seem to embody differing levels of commitment to accomplishing their goals in the face of difficulty. I

conclude this chapter by suggesting that for the preservice teachers in this sample, their agency is an individualized process, mediated by a multitude of ever-changing contextual factors and initiatives allowing participants to meet their goals.

Chapter 9. Implications and Conclusion

In this concluding chapter, I describe the implications of my research for the conceptualization of preservice teacher learning in terms of prior histories, intentions behind technology use, and how preservice teachers can contribute to their classroom communities. Next, I expound on my implications by suggesting areas of future research, methodological contributions, and practical applications for TEPs, university teacher educators, mentor teachers, and policy makers. I close this chapter with an outline of my study's limitations and my thoughts about teacher educators working alongside preservice teachers to meaningfully integrate technology into TEPs.

CHAPTER 2

Exploring the Complexity of Preservice Teacher Learning

Over the past few decades, three main conceptualizations of preservice teacher learning have informed the design of TEPs (Russ et al., 2016). First, a process-product approach defines preservice teacher learning as a change in observable actions. Learning is considered to occur as a result of teachers taking up specific practices that are universal and connected to student learning outcomes. Researchers acknowledge that the process-product model does not account for preservice teachers' thinking about their pedagogical actions. To address this concern, a second approach based in theories of cognition gained steam in the field and began to include research on preservice teachers' beliefs about teaching and learning (Russ et al. 2016). From this era in teacher education research, Shulman's (1986) foundational Pedagogical Content Knowledge theory urges novice and established teachers to think critically about effective pedagogical approaches for specific academic subject areas.

More recently, the field of teacher education has shifted from a focus on preservice teachers' thinking as being taking place in one's mind to a more sociocultural approach situating teacher learning within larger cultural contexts, and mediated by conceptual and practice-based tools (Putnam & Borko, 1998). Taking a situated approach privileges the contextual nature of preservice teacher learning and allows researchers to explore how teachers negotiate their learning through participation in cultural contexts over time (Fishman et al., 2014). Olsen (2008) calls for teacher educators to "recast learning-to-teach as a continuous, situated, holistic knowledge-and-identity process, in which prior experiences produce deeply embedded ways of viewing the world that goes on to organize current/future experience into meaning" (p.6). I draw on Olsen's conception in this dissertation to articulate a stance toward preservice teacher

learning as a complex and dynamic process mediated and distributed across interconnected influences. These influences include individuals (teacher educators, cohort peers, students, etc.), contexts (home, communities, university classes, school placements, virtual spaces) and tools (concepts of teaching and learning, curricula, physical environments, and digital technologies). To account for the ongoing nature of the teacher learning process, I adopt Magdalene Lampert's (2010) phrase 'learning teaching' to use throughout this dissertation. The term describes the continuous process by which learning can occur over the course of teaching, and through relational work with students and subject area content over time.

I organize this chapter into two main sections. I begin by introducing the phases of teacher learning and focus on what preservice teachers learn in their TEPs. To answer this question, I outline the conceptual knowledge, dispositions, and practices presented in university-based courses and fieldwork. However, what preservice teachers learn is connected to how they learn it. In the second section, I explore how preservice teachers learn. I describe the influence of their personal histories and then examine their learning using a situated perspective to discuss how preservice teachers learn through mediated participation within and across multiple communities of practice. I also highlight the relevance of tools in distributing knowledge and teaching expertise. I conclude by focusing on preservice teachers as intentional actors in the contexts of their programs, addressing issues of agency.

Learning Teaching as a Lifelong Trajectory

It has been well-established that preservice teacher learning takes place as part of a life-long trajectory of learning to teach (Cochran-Smith et al., 2016). As an ongoing process, learning to teach spans across teachers' lives (Clandinin & Husu, 2017). Prior research by Feiman-Nemser (2012) establishes four influential phases in learning to teach. First, the *pretraining*

phase acknowledges years of informal learning experiences (e.g., time as a K-12 student, learning from families) accumulated by preservice teachers before entering their TEPs (Lortie, 1978; Russ et al. 2016; Trotman & Kerr, 2001). The second phase, *preservice learning,* occurs as they participate in the different settings of their TEPs, such as university courses and student teaching placements. My dissertation is concerned with the first two phases of teacher learning. The third phase, *induction*, spans their first few years on the job and the fourth phase, *inservice*, encompasses the remaining years of their careers.

What Do Preservice Teachers Learn?

Since the needs of K-12 students are constantly changing, so do the parameters of *what* preservice teachers should be learning in their TEPs (Darling-Hammond et al., 2019). Broadly speaking, TEPs can be designed to support preservice teachers in developing a professional vision of teaching (Bransford et al., 2005). This vision includes seeing themselves as professional teachers, developing conceptual knowledge, knowledge of students, subject-area knowledge, dispositions, and pedagogical approaches with practical skills within the context of their classrooms and schools. However, these elements of teacher development are not learned or applied in the linear order presented above. Instead, teacher educators can take a holistic approach to weave together understandings, skills, and knowledge to support preservice teachers in becoming responsive teachers (Hollins, 2011).

Conceptual Knowledge

Central to the process of learning teaching is building a comprehensive understanding of how students learn using contemporary theories of development, with a focus on language-learning, different ways of knowing, and student diversity (Darling-Hammond & Bransford, 2005). Preservice teachers also need to develop a strong sense of subject-area content and

corresponding pedagogical strategies to effectively engage students in learning (Shulman, 1986). In addition, they need to learn how to "connect disciplinary knowledge and practices to the everyday experiences of learners from diverse cultural, linguistic, and experiential backgrounds" (Hollins, 2011, p. 397). It is essential that preservice teachers build a solid foundational understanding of how students learn, spanning all facets of students' lives. Beginning teachers can, in turn, design learning experiences that value the diversity of their students' learning needs.

Dispositions

While it is critical that preservice teachers build a foundation of knowledge about their students and subject matter, they also need support in developing professional dispositions to guide how they use their knowledge (Hammerness et al., 2005). Preservice teacher dispositions can consist of their commitments, attitudes, and sensibilities towards applying their understanding of teaching and student learning (Feiman-Nemser & Remillard, 1995). Examples include varying commitments to social-justice teaching (Mills, 2009), attitudes towards family relationships (Baum & Swick, 2008), and sensibilities in making judgments to uphold student confidentiality (Hillman et al., 2006). Teacher educators also argue that preservice teachers can benefit from developing other dispositions, such as self-reflection to their raise awareness of themselves and the complexity of their teaching contexts (Zeichner & Liston, 1985).

Existing research on dispositions tends to focus on preservice teachers' thinking, rather than how their dispositions impact actual teaching practice (Anderson & Stillman, 2013). Hammerness et al. (2005) expands this interpretation by defining dispositions as "habits of thinking and action" (p. 387). Thus, the habitual thought processes preservice teachers begin to develop in their coursework and during student teaching placements can inform how they understand their practice as teachers. However, much of this research focuses on the dispositions

supported by knowledge and experiences formed in formal educational spaces. Zeichner and Payne (2013) urge us to think critically about "whose knowledge counts" (p.3) and expand the sphere of legitimate expertise to include K-12 practitioners and local community examples. Russ et al. (2016) also challenge the established view of specialized professional teacher knowledge and dispositions, suggesting that we include everyday ways of communicating that teachers develop before their TEPs. For example, they describe how a teacher can refine their everyday conversational practices such as reading body language and facial expressions when leading a class discussion.

Practices

The next layer in the dynamic learning-teaching process is for preservice teachers to utilize their knowledge and dispositions to guide their repeated actions as teachers, otherwise known as their practices. While there are varying definitions of *practice* proposed in teacher education literature, Lampert (2010) points to the ways in which teaching can be understood as a collection of practices informed by theories of learning, while also supporting the daily work of teaching. In their TEPs, preservice teachers, to varying degrees, start to build a "basic repertoire of practices" (Feiman-Nemser, 2001, p. 1081), including methods for planning, enacting, and assessing student learning. Over the past decade, some researchers and teacher educators have endorsed practice-based approaches to support preservice teachers' abilities to enact practices designed to increase the quality of disciplinary learning opportunities for students furthest from educational justice (McDonald et al., 2013). In this view, preservice teachers can learn and refine core or high-leverage teaching practices rooted in the complexity of the classroom, but that also break down the components of teaching into manageable steps (Grossman et al., 2009).

However, Thomas et al. (2019) raise concerns that teaching core practices reduces the improvisational component of teaching that arises from social interactions with students.

Thus far, I have presented a picture of what preservice teachers learn by focusing on individuals' understandings of learning theory, pedagogical practices, and ways of thinking to guide teaching practices. However, this description of what preservice teachers learn is missing a central component: the contextualized nature of what is learned. Preservice teacher learning is inherently situated, and therefore *what* they learn is coupled with *how* they learn it (Darling-Hammond et al. 2019). In the following section, I expand the discussion of what preservice teachers learn to probe how they learn.

How Do Preservice Teachers Learn?

Recent research suggests that learning teaching as a situated process in which novice teachers develop contextualized knowledge and practices through relational experiences (Kennedy, 1999; Hammerness et al., 2005; Cochran-Smith et al., 2016). This continuous learning process is driven by teachers' evolving participation within and across social communities. As such, how one learns to teach is not a predetermined process with a clear endpoint. It is instead practiced; it is a constant and ever-changing negotiation occurring on personal and social levels in which teachers wrestle with tensions between their personal histories, commitments, and the realities of teaching in their current classroom contexts (Britzman, 2003).

The Influential Role of Preservice Teachers' Prior Histories

Preservice teachers' personal histories, or biographies, have long been studied for influencing what and how preservice teachers learn in TEPs. Typically, preservice teachers' prior histories are analyzed in terms of their experiences as students, and the beliefs and values about teaching and learning developed before entering TEPs (Holt-Reynolds, 1992). A significant

portion of their biographies is formed from years spent observing teachers in close proximity. Lortie (1975) coined the term of this phenomenon the "Apprenticeship of Observation" (p. 61) and warns that students develop a limited view of teachers' work by observing without access to their teachers' pedagogical and critical decision-making practices. Preservice teachers' personal histories can also include informal examples, such as everyday knowledge drawn from conversations and inference-making (Russ et al., 2016). It is also worth noting that preservice teachers' personal histories are unique in that they each are informed by distinctive experiences (Knowles and Holt-Reynolds, 1991). In addition, preservice teachers are steeped in a cultural milieu in which stereotypes abound around the work of teachers, thus shaping the former's view of the profession (Britzman, 2003). Altogether, preservice teachers' prior histories act as an influential element in how they learn to teach (Feiman-Nemser, 2012).

Preservice teachers have belief systems about teaching that arise from their prior educational histories. These belief systems and memories of past schooling experiences act as a filter or standard with which to measure information presented in TEPs (Knowles & Holt-Reynolds, 1991). Often, it is difficult for preservice teachers to critically examine their beliefs (Feiman-Nemser & Remillard, 1995). When the information or practices presented do not align with their preconceptions of teaching, preservice teachers may reject them and fall back into familiar patterns of teaching (Trotman & Kerr, 2001). Preservice teachers' histories can also play a role in shaping how they understand the settings in which they are learning to teach, and can influence how they think about and participate in these settings (Grossman et al., 1999). Overall, the phenomenon of preservice teachers using their personal histories as filters is problematic because some preservice teachers talk about their experiences in compulsory education as being generalizable to other students (Knowles & Holt-Reynolds, 1991). Thus, preservice teachers may

struggle to see past their experiences and fail to expand their vision of teaching to include the richness of all students' learning experiences, as well as the complexity of their classrooms.

Learning to Teach Through Social Interaction

Broadly speaking, preservice teachers begin to learn the practice of teaching through social interactions with different people in various communities, and facilitated by specific tools (Russ et al., 2016; Darling-Hammond & Oakes, 2019). These social interactions span a range of complex mental functioning and adaptive actions that teachers implement throughout their day. Cochran-Smith et al. (2016) describe this range of social interactions between preservice teachers, mentor teachers, and peers as "exchanging ideas, articulating reasoning behind instructional decisions, engaging in inquiry aimed at solving specific problems of practice, and reflecting on one's teaching to improve student learning" (p.481). Thus, preservice teachers learn through different processes of discussion, enactment, and self-reflection to continually shape their practice and understanding of themselves as teachers (Britzman, 2003). Another critical aspect of teaching as a social process is the interactions preservice teachers have with their students. Preservice teachers engage directly with their students to build a shared set of participation expectations and learning practices. The teacher-student relationship is built up through a series of interactions with individual students, subject area content, and the class as a whole group (Lampert, 2010). In this way, preservice teachers and students learn together through relationship-building (Cherrington, 2017) in their shared community (Russ et al., 2016).

Learning to Teach in Communities of Practice

Preservice teacher learning through participation is a contextualized process situated within communities of practice in which learning is distributed across people and tools (Fishman et al., 2014). Following Wenger's (1998) conception of a community of practice, preservice

teachers are active participants who take part in and shape practices shared by groups in university classes and field placements. Examples include cohorts of preservice teachers forming communities of practice while in their formal coursework (Korthagen, 2017) and mentor teachers, preservice teachers, and students forming learning communities in schools (Hammerness et al., 2005). Key to this concept of learning through a progression of participation is the intentionality of teacher educators in developing and supporting communities of practice rich with context-specific resources. Darling-Hammond and Oakes (2019) posit cultivating communities of practice rooted in equity with purposeful experiences where preservice teachers engage with concepts, issues, people, and tools while receiving consistent feedback on their practices. Communities of practice play a pivotal role as spaces for preservice teachers to become "enculturated into the teaching community by learning to think, talk, and act as a teacher (Putnam & Borko, 2000, p.10). However, these learning experiences can be ripe with tension, as preservice teachers wrestle with disparities between their preconceptions for teaching and the realities of the profession (Smagorinsky et al., 2004).

While I have made a case for the idea of preservice teacher learning occurring through social engagement within intentional communities, we must also consider the broader social systems that impact these communities (Cherrington, 2017). TEPs are situated in broader social, cultural, economic, and political systems that impact their work. Specifically, state and national governing boards can influence the structure of teacher education programs and the range of freedoms they have to define their approaches to preparing future teachers (Dolan, 2017). Taking an ecological approach also allows for the inclusion of outside school spaces such as neighborhood communities surrounding field placement schools. As such, it is essential for preservice teachers to have extended and meaningful opportunities to learn about the wealth of

cultural practices supporting student growth in their neighborhoods and communities (Zygmunt et al., 2016).

Teacher Education Program Settings

Over the past decades, TEPs have shifted from being offered in normal schools to colleges and universities (Fraser, 2007) with two main settings for preservice teacher learning: (1) university-based coursework and (2) student teaching placements. The field of teacher education has long studied and discussed the relationships among these settings and their influential contextual factors. The main idea emerging from this enduring conversation is the separation, and resulting tensions between, universities and schools (Zeichner, 2010).

University-based Coursework

In the space of a university classroom (in-person or virtual), we see different stakeholders (teacher educators, preservice teachers, mentor teachers, students, and families) interact with each other and with other structural elements of the teacher education program (university buildings and course designs) and with tools (knowledge, dispositions, and practices). One way that preservice teachers navigate the complexity of learning in their academic courses is by forming cohort-based communities of practice. Preservice teachers can develop these learning communities when they are able to form relationships and interact with each other in academic and social ways that promote discussion, shared experiences, and reflection (Korthagen, 2017). In this view, preservice teachers develop shared practices for learning teaching through whole-class discussions, small group activities, and individual assignments.

Teacher Educators in Coursework

As an important contextual feature, teacher educators play a critical role in designing learning opportunities for preservice teachers. Teacher educators design coursework and hands-

on experiences to support preservice teachers in developing their understandings about specific subject matter pedagogies (Cochran-Smith et al., 2016). For some teacher educators, taking a practice-based approach provides opportunities to use "nested sets of enactment and investigation" in which preservice teachers observe, research, practice, and reflect on a specific practice (Kazemi et al., 2016, p.20). Viewed through a community-of-participation lens, this approach scaffolds preservice teachers' participation as they access and try on ways of thinking, speaking, and acting presented by more experienced community members. In other words, preservice teachers learn aspects of teaching by building contextualized knowledge, and experience the relational aspect of teaching by applying practices mediated by their teacher educators.

Pedagogical Tools in Coursework

A situated view of teaching highlights the importance of tools in distributing knowledge across people and settings (Fishman et al., 2014). Applied to preservice teacher learning, this can refer to pedagogical tools such as conceptual and practical resources (Grossman et al., 1999) and tools cultivated in everyday practices (Russ et al., 2016). According to Grossman et al. (1999), conceptually based tools in preservice teacher learning can include theories, principles, and frameworks to guide their approach to teaching and learning. In addition to these formal, academically-based conceptual tools, Russ et al. (2016) argue that teachers develop conceptual tools through everyday interactions that can support their teaching. They provide examples for how people construct meaning from everyday conversations by generating personalized representations of words used around them. However, Russ et al. (2016) note these everyday practices need refining during teacher-education training to be effectively applied to the classroom.

Preservice teachers can utilize their conceptually-based resources to meaningfully engage with more practical based tools (McDonald et al., 2014). The line between conceptual and practical tools is blurred as they overlap and, at times, are mutually constitutive (Lampert, 2010). Examples of practical tools can include curriculum materials, instructional approaches (Grossman et al., 1999) as well as more productivity tools such as electronic devices (Putnam & Borko, 2000). Because teaching is a mediated practice requiring contextualized knowledge, preservice teachers benefit from learning through the use of specific subject-area practical tools. For example, to support preservice teachers in understanding the planning and enactment phases of ambitious science teaching, Windschitl et al. (2012) design and implement high-leverage practices with corresponding digital tools. Because this dissertation focuses primarily on preservice teachers' use of digital technologies, I will cover this topic in greater detail in a subsequent chapter.

Contextual Factors Present in Student Teaching Placements

Ideally, the classroom as a community of practice should be a rich space for learning. Preservice teachers can develop meaningful relationships with mentor teachers and students and access the groups' practices and resources (Cherrington, 2017). However, there is concern about the limited scope of practices modeled in a mentor teacher's classroom if their approach to teaching does not align with reform efforts promoted by the university (Putnam & Borko, 2000). One way to approach studying the complexity of the student teaching experience is to focus on its situated nature, identifying preservice teachers 'opportunities to learn' (Cohen & Berlin, 2019). Research teams such as Windschitl et al. (2020) describe using 'opportunities to learn' to study the influence of contextual factors on occasions preservice teachers to meaningfully learn

aspects of teaching in their student teaching classrooms. Their research highlights the critical role mentor teachers can play in enabling or constraining preservice teachers' learning opportunities.

The Role of Mentor Teachers in Student Teaching Placements

Given that preservice teachers are newcomers to their student teaching classroom communities, they rely on mentor teachers to provide access to their decisions as experienced teachers and the resources preservice teachers need to grow as future teachers (Cherrington, 2017). Mentor teachers can effectively model contextually-based practices, share their reflection process by co-planning with preservice teachers, facilitate repeated occasions to teach, and provide consistent feedback (Hammerness et al., 2005). As such, mentor teachers can take on a dual role of modeling practices and providing helpful feedback (Matsko et al., 2020). However, researchers have identified disparities between preservice teachers' ideas around teaching and learning and those of their mentor teachers. This tension can constrict how preservice teachers participate in their student teaching classroom (Smagorinsky, 2004). Mentor teachers may believe that student teachers should follow their lesson plans with fidelity or experiment with their own ideas (Valencia et al., 2009).

Further research explores the implications of mentor teachers' beliefs about teaching and learning on preservice teachers' opportunities to contribute to their classrooms. In terms of planning opportunities, preservice teachers who share similar views as their mentor teachers around science instruction are offered a greater number of opportunities for planning than their peers, who held different views than their mentor teachers (Windschitl et al., 2020). In contrast, there are some instances where researchers have documented preservice teachers opening up small opportunities to implement lessons that may not align with their mentor teachers' practices or mandated school curricula (Anderson & Stillman, 2013). Yet in the cases where preservice

teachers enact their own lesson ideas, mentor teachers can struggle to provide accurate feedback (McDonald et al., 2014). The research above presents a range of preservice teachers' experiences within their student teaching placements, and the significant role mentor teachers play in providing access to relational and resource-based aspects of classroom learning communities.

Students in Student Teaching Placements

Framing teaching as a relational and contextualized practice means that we also need to account for the relationships preservice teachers develop with their students, and the understandings they form around such interactions. In this view, preservice teachers work in concert with their students to build their classroom community and ways of participating (Putnam & Borko, 2000). Student teaching, then, can be an opportunity for preservice teachers to practice learning about students in terms of their prior knowledge, ways of learning, languages, and cultural experiences (Hollins, 2011). Accordingly, teaching is a relational practice developed through momentary interactions and longer trajectories of engagement between students, subject matters, and teachers (Lampert, 2010). As preservice teachers become more adept at learning about their students, they can use that information to inform their decisions, thereby moving closer to becoming professional teachers (Cochran-Smith et al., 2016).

Pedagogical Tools in Student Teaching Placements

Given that teaching is a mediated and distributed practice, conceptual and practical tools are central elements that facilitate preservice teachers' participation during their student teaching placements. Similar to university courses, conceptual tools in classrooms can be standards or frameworks for learning (Grossman et al., 1999) and more general ideas to support learning like exploration and reflection (Hogan et al., 2018). To support their conceptually driven pedagogical approaches, preservice teachers use practical tools (Grossman et al., 1999) such as unit plans,

worksheets, games, videos, art materials, to name a few. Student teachers can take up and understand how to use different tools overtime based on contextual and personal factors (Hebard, 2016). It is important to note that in some cases, preservice teachers choose not to engage with certain tools because they do not align with the norms of their student teaching placement (Grossman et al., 1999) or their understanding of good teaching (Ball & Feiman-Nemser, 1988). Yet again, reinforcing the influential role of personal and contextual factors in preservice teacher learning.

Preservice Teacher Agency

Given that preservice teacher learning occurs through participation in sociocultural communities, we must attend to how preservice teachers understand the scope of their actions as well as their abilities to perform these actions. Preservice teachers find themselves in complex situations, in which they fluctuate between inhabiting the roles of students and teachers (Knowles & Holt-Reynolds, 1991). The tensions inherent in this oscillating role necessitates studying how preservice teachers understand their own complex agency through the range of actions within and across different TEP communities.

To make sense of this phenomenon, I use the concept of agency from a sociocultural perspective, in which all actions are mediated. This implies that preservice teachers' thinking, speaking, and actions during the process of teaching and learning are influenced in part by their experiences as students in school settings (Lortie, 1979), cultural norms (Weber & Mitchell, 1996; Britzman, 2003), personal experiences (Olsen, 2008), and present contextual conditions (Wertsch, 1998). Furthermore, preservice teachers' actions can be located on a spectrum from complying to resisting the practices and norms of the group in which they are participating (Gresalfi, Marin, Hand & Greeno, 2009).

Researchers in the field of teacher education have studied preservice teacher agency in terms of how to prepare agentic future teachers (Lipponen & Kumpulainen, 2011). Britzman (2003) warns that teaching does not mean applying a set of standardized skills to all situations, and we should not prepare teachers to conform to historically problematic approaches to teaching. Instead, TEPs can prepare future teachers to take active steps to make sense of the complexity of their teaching contexts and advocate for the needs of their students (Zeichner & Flessner, 2009). 'Agentic teachers' can be understood as teachers committed to using inclusive pedagogies and striving for high quality and equitable education for all students (Pantić & Florian, 2015). Common to these perspectives on agentic teachers is their commitment to using a critical lens to analyze their current situations. Extant research suggests ways to create learning environments for preservice teachers to exercise agency.

Shifting the Power in Teacher Education Programs

Teacher educators have honed in on specific contextual features, such as power relations between teacher educators (i.e., university faculty and mentor teachers), curriculum pressures, and preservice teachers, that can be shifted in order to increase opportunities for preservice teachers to exercise agency. In university learning spaces, Lipponen and Kumpulainen (2011) describe teacher educators cultivating spaces where traditional teacher-student boundaries are challenged by centering preservice teachers' voices and visions of assignments. The authors argue that challenging the 'faculty as an expert model' opens up space for preservice teachers and teacher educators to develop a shared learning community. As such, Klehr (2015) finds that her preservice teachers benefit from exercising agency to transform their seminar class to include more community voices. Meanwhile, in their university course, Kumpulainen et al. (2012) utilize

a narrative writing assignment to facilitate preservice teacher reflection and subsequent knowledge development to increase their agency as future decision makers in schools.

In terms of student teaching classrooms, preservice teachers exercising agency is complicated by their position as student teachers in mentor teachers' classrooms. In studying the dynamics of such a classroom, Moate & Ruohotie-Lyhty (2014) propose that preservice teachers can benefit from mentors providing opportunities to authentically engage in robust lesson planning to grapple with the conceptual and practical aspects of teaching. Building on the relational aspects of preservice teacher agency, Edwards and D'Arcy (2004) suggest that when preservice teachers are under pressure to teach a given curriculum to fidelity, they can miss out on learning how to work with students to develop a shared understanding of subject matter.

Chapter Summary

I created a visual representation (Figure 2) to summarize the six dimensions of preservice teacher learning presented in this chapter. Beginning on the top right corner with a **maroon** hexagon, I highlight the significant role that preservice teachers' prior histories play in what and how they learn in their TEP. I understand preservice teacher learning as occurring through social interactions like participation within the multiple settings of their TEP (see the lavender hexagon to the lower right). Furthermore, the **teal** hexagon to the bottom shows that preservice teacher learning is an ongoing process situated within and across the many TEP settings. These settings are composed of influential contextual factors shaping how preservice teachers learn through social interaction, such as participating in communities of practice formed in and across their program settings. Central to this claim is the mediated experience of participation, in which preservice teachers use various conceptual and material tools in their social interactions to support their thinking and actions within the classroom.

Moving to the bottom left hexagon, preservice teacher learning is conceptualized as occurring over multiple stages of their careers. As they develop into teachers, they learn (in different degrees) conceptual knowledge, dispositions, and practices to guide their work (see the **grey** hexagon). And as preservice teachers learn specific knowledge and gain experiences as future teachers, they work in different ways to contribute to their classroom communities and exercise agency in developing curriculum, pedagogical approaches, and relationships with students. Taken together, these six dimensions of preservice teacher learning and their interconnected nature provide a solid sociocultural foundation for my dissertation. In the next chapter, I will build on this conception of learning to explore how preservice teachers use digital technologies as tools to support their learning before and during their TEP.

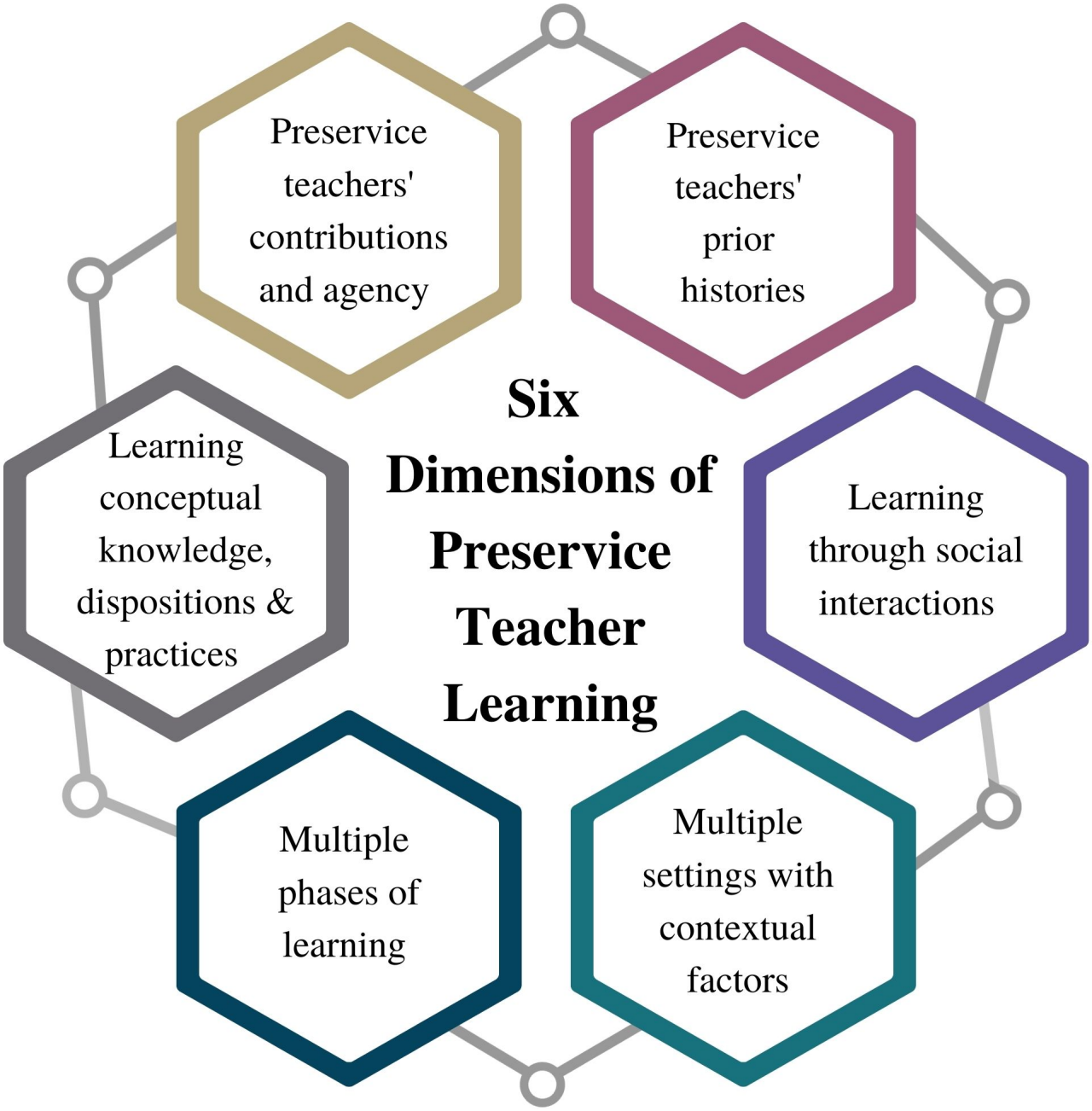


Figure 2. A visualization of the six dimensions of preservice teacher learning.

CHAPTER 3

The Three Research Strands of Preservice Teachers and Technology

In my previous chapter, I made the case that preservice teachers can learn teaching (Lampert, 2010) in part through mediated participation using conceptual and practical tools. In this chapter, I examine how preservice teachers use a specific sector of tools: digital technologies. Digital technologies are significant tools in preservice teachers' learning — as many teachers have grown up in a digitally-mediated world where they use them to facilitate their daily activities (Donovan & Hansen, 2011). Preservice teachers also need to be prepared for a profession that is becoming increasingly reliant on technology to facilitate the work of teaching (Starkey & Starkey, 2020). Thus, it is crucial for teacher educators to examine how and why preservice teachers use digital technology in their TEPs.

There are three main strands of research exploring preservice teacher learning with technology that are relevant to this dissertation. First, researchers study preservice teachers' experiences with technology prior to entering their TEPs. This category of research investigates how preservice teachers' prior experiences shape their knowledge and beliefs and impact how they will use technology in their learning and future teaching. The second strand of research explores how preservice teachers use technology, mostly provided by teacher educators, to learn specific knowledge and dispositions central to the teaching profession. These studies tend to occur during university coursework in the form of assignments or interventions to increase preservice teachers' knowledge and skills, such as critical reflection. The third category of research examines how preservice teachers are prepared to teach with technology. The studies in this category investigate the nature and effectiveness of educational technology courses and the opportunities and barriers for technology use in student teaching classrooms.

Preservice Teachers' Technical Knowledge and Dispositions

A growing amount of research in the field of teacher education and technology explores preservice teachers' experiences and ways of thinking about technology before and during their TEPs. Much of this research rests on the foundational claim that preservice teachers' prior experiences and resulting ideas about the value of technology are significant factors influencing if and how they will use technology in their teaching (Ching & Vigdor, 2005). Thus, researchers investigate preservice teachers' knowledge about technology gained from first-hand experiences in and outside school spaces and how those experiences shape their dispositions towards using it. Preservice teachers' dispositions can include their beliefs, perceptions, and their degree of self-efficacy in using technology throughout their lives in and outside of school. Although connections between preservice teachers' prior experiences and current thinking patterns have been established (Chen, 2010), and it is critical that teacher educators understand that cohorts of preservice teachers as groups of unique learners with variations in their digital practices (Mukama, 2010).

Variation in Preservice Teachers' Experiences with Technology

Research into preservice teachers' experiences with technology reveals that within cohorts, preservice teachers come with a diversity of experiences and ideas about technology (Buss & Fulton, 2012). The variation in their experience encompasses their technical knowledge (Valtonen & Siegl, 2018), their experiences using technology in K-12 spaces (Funkhouser & Mouza, 2013), and their uses of it outside of school (Ching & Vigdor, 2005; Mukuma, 2010). Some researchers adopt Prenskey's (2001) digital native concept or Oblinger & Oblinger's (2005)'s net generation label to group preservice teachers by age and lifelong immersion in technology. Yet, multiple studies show that while preservice teachers who grew up with digital

technology may be more familiar with and use digital technologies at higher rates in their daily lives than older students, they are not necessarily more prepared to use it in their teaching (Lei, 2009). In discussing the variation in preservice teachers' digital practices, Burnett (2011) cautions against this type of age-based categorization and against using labels like "digital insider or outsider" (p.444-5) to describe preservice teachers. I take up Burnett's call to not categorize preservice teachers and as a result, in this dissertation, I explore the complexity of each participant's digital life in light of their interests and prior experiences.

Instead of grouping students into constraining categories, TEPs may try to understand the complexity of preservice teachers' digital experiences to better support their learning needs with technology (Valtonen & Siegl, 2018). To accomplish the goal of learning about preservice teachers' experiences and approaches to using technology, Tondeur et al. (2012) recommend forgoing tests to gauge preservice teachers' technology skills and instead suggest taking a more nuanced approach. For example, teacher educators can design coursework with opportunities for preservice teachers to reflect on their histories with technology (Graham, 2008). In practice, Burnett (2009) and Ching & Vigdor (2005) take a narrative-based approach where preservice teachers recall and tell stories about their digital histories. The sum of these studies indicates that preservice teachers' lives with technology are varied in their composition and can be positioned as valuable histories for self-reflection and investigation.

Preservice Teachers' Technical Knowledge

Preservice teachers' knowledge about technology can be traced to their prior experiences using technology in and outside of school. Researchers investigate preservice teachers' technical knowledge in terms of their fluency using specific information and communications technologies (ICT) and where they learn to use their digital tools. For example, Lei (2009) suggests that

preservice teachers spend most of their time with digital devices on socially-based activities, such as viewing and sharing digital content like photographs (Kumar & Vigil, 2011). A close examination of preservice teachers' technical knowledge not only serves teacher educators' interests but can also function as a valuable reflective practice for preservice teachers as they make sense of the connections between their prior and current practices (Burnett, 2009). Preservice teachers can increase both their awareness of the ecological nature of their digital lives (Ito et al., 2013) and their understanding of the interrelationships between themselves, other stakeholders (e.g., colleagues and students), devices and digital practices (Matthew, 2020).

Preservice Teachers' Digital Competence

There is a growing body of research examining preservice teachers' general digital competencies. By focusing on more general digital practices that develop in and outside of school, researchers acknowledge the broader scope of digital practices that preservice teachers as well as inservice teachers culitvate before and during their careers (Starkey & Starkey, 2020). Examples for preservice teachers' general digital competencies can include but are not limited to their use of presentation software, word processing programs, spreadsheets and databases, email, the Internet, and their overall technological awareness (Maderick et al. 2016). Notably, digital competencies are not constrained to specific skills with ICT; instead, Ferrari (2012) posits that it includes the "knowledge, skills, attitudes (this includes abilities, strategies, values, and awareness)" (p.3) for using digital tools and media to participate in today's world. Thus, preservice teachers' digital competencies are multidimensional (Cantabrana et al., 2019) and dynamic as the competencies grow to encompass preservice teachers' technical knowledge and how they integrate it into their pedagogical approaches based on the unique social and cultural settings of their classrooms (Instefjord, 2016).

Influential Factors in Preservice Teachers' Technical Knowledge Development

Contextual features such as environmental conditions and social relationships are influential factors in how preservice teachers develop their digital knowledge. Along these lines, preservice teachers have discussed the ways in which they have gained access to and learned how to use specific digital devices and applications in socially-based spaces like homes and workplaces. For example, preservice teachers sometimes name notable people like family members who provided them with home computers and training (Ching & Vigdor, 2015) as well as supported their appreciation of specific media (Kist, 2017). Preservice teachers also share how friends provide opportunities to learn how to use digital technology like video games, which they operate together to maintain friendships (Ching & Vigdor, 2015). While some preservice teachers discuss the ways in which they learned skills and attitudes towards using technology from important people in their lives, others describe being 'self-taught'(Graham, 2008). The sum of these studies suggests that preservice teachers gain knowledge and experiences with technology from various context-based interactions (Burnett, 2011), which further highlights the unique and personal qualities of their digital histories.

Preservice Teachers' Dispositions

I use the term dispositions to signify how preservice teachers approach technology based on their beliefs, attitudes, perceptions, values, and motivations. Preservice teachers' perceptions of the value of digital tools impact their willingness and interest in using them during their TEPs. Preservice teachers with positive attitudes and confidence about using technology seem to more actively incorporate it into their teaching (Greene, 2011; Kent & Giles, 2017). However, preservice teachers' beliefs about using technology may be more teacher-centered, such as presenting with PowerPoint (Donovan & Hansen, 2011), and this focus can inhibit them from

taking a more preferred student-centered approach for using technology in ways that forefront student engagement (Funkhouser & Mouza, 2013). With that in mind, TEPs need to have a clear understanding of their preservice teachers' dispositions and prior knowledge to support them in learning how to use technology in their classrooms (Donovan & Hansen, 2011). In doing so, teacher educators can also uncover internal and external hurdles that may impede their use of technology (Li et al., 2015).

The Role of Teacher Education Programs in Learning with Technology

Given that each cohort of preservice teachers begins their TEPs with diverse and unique technical knowledge, skills and dispositions, how do the contextual factors present in their university courses impact their opportunities to use technology? State standards and more localized teacher educators play a significant role in what preservice teachers learn with and about technology and how they learn it. I will begin by exploring what research tells us about teacher educators and their influential role in integrating technology into TEPs. Next, I will present research showing how teacher educators design assignments to support preservice teachers to increase their technical knowledge, subject-area content, and dispositions.

Teacher Educators as Teachers with Technology

Prior research has shown that though preservice teachers may have years of experience using technology to mediate their lives outside of school, they still require support to learn how to integrate technology into their teaching (Lei, 2009). In this scenario, teacher educators are positioned as important actors who can model and explicitly discuss the incorporation of technology in teaching and learning (Tondeur et al., 2012; Admiraal et al., 2017). Teacher educators can push themselves and their preservice teachers to use technology in ways that both challenge the status quo of teacher education as well as transform learning (Trust, 2017). In this

view, teacher educators do not choose technology for technology's sake; rather, they consider how to use technology to increase preservice teachers' opportunities for critical thinking and raise their personal connection to course materials (Mirra, 2020).

The Design of Learning Opportunities with Technology

Teacher educators can answer the call for more technology integration by building a repertoire of practices with technology that engage preservice teachers in learning through the process of "creation, production, and problem-solving" (United States Department of Education Office of Educational Technology, 2016; Trust, 2017, p.44). Teacher educators can take up this practice through constructivist approaches to learning with technology that provides preservice teachers with opportunities to construct knowledge through the production of multimodal assignments (Degennaro, 2010) and peer feedback (Keppell et al., 2006). Other approaches include teacher educators adapting the Connected Learning framework[2] (Ito et al., 2013) to support their use of more authentic teaching problems to solve in groups using technology (Herrington et al. 2014). Building on the Connected Learning perspective, Mirra (2020) urges teacher educators to reimagine using technology in preservice teacher learning in ways that advocate for increased levels of civic participation and discussion of equity issues in education.

Teacher educators' goals for preservice teachers' learning experiences are central to the above approaches for designing technology-enhanced learning environments. In many studies, teacher educators consider a tool's effectiveness to support in-the-moment learning while also accounting for the time needed to discuss its implications for teaching (i.e. Hallman 2012). This suggests that teacher educators may be guided by two overarching goals for using technology.

[2] The Connected Learning Framework explores how meaningful learning opportunities can be cultivated by leveraging students' interests, technical skills, intergenerational relationships, academics, and civic participation.

First, using it to support preservice teachers learning specific content and technical skills. Second, preparing preservice teachers to use technology in their teaching. Below, I will discuss extant research about the first goal: setting up experiences for preservice teachers to use technology to learn within their foundations and methods courses in university settings.

Preservice Teachers Learning Subject-area Content and Skills. Teacher educators tend to try two approaches to using technology in TEPs: they either choose a specific tool or they engage in the more comprehensive process of integrating multiple tools into their courses. In terms of singular digital tools, teacher educators highlight the affordances of using video recordings in methods classes to provide preservice teachers access to teaching episodes (van Es, 2006). In using more than one tool, teacher educators experiment with integrating multiple devices and digital applications including laptops, iPads, web-based simulations, videos, and websites into constructivist-based learning activities (Rehmat & Bailey, 2014). In an English language arts methods course, Mirra (2020) engaged her preservice teachers in a variety of digitally-mediated assignments such as blog posting, multimodal text production, and interviewing young people about their digital literacy practices.

While these examples focus on specific methods courses, Donovan and Hansen (2011) expand the reach of technology to encompass all of the preservice teachers' university coursework and their personal digital practices. In their 2011 study, a group of preservice teachers was given laptops, and directions for integrating digital applications into their individual assignments. The preservice teachers were also encouraged to use technology to facilitate peer collaboration and for personal use. With their devices in hand, preservice teachers showed growth in their beliefs and skills using technology.

The above examples show the potential of integrating technology into university courses using devices and digital applications to support preservice teachers in learning content. However, in these instances and other available examples the majority of the digital tools were chosen by teacher educators. We know much less about the preferences of preservice teachers when it comes to choosing tools to support their learning.

Preservice Teachers Learning Digital Skills. Teacher educators and researchers specifically design course assignments for preservice teachers to grow their technical skills and expand their visions for incorporating technology into their teaching and student learning. Avenues of research focus on increasing preservice teachers' general digital competence, confidence using specific tools, and deepening their understanding of the pedagogical value of particular digital tools (Starkey & Starkey, 2020). Preservice teachers commonly learn how to use digital creation tools to increase their technical skills. For example, preservice teachers in a science methods course experimented with creating videos, co-editing videos, and making visual representations of scientific phenomena (Barak, 2017). In other instances, preservice teachers created digital stories and blog posts where they could develop deep knowledge through the construction process (Boulton & Hramiak, 2014; Shelton et al., 2017). These narrative-type assignments encourage preservice teachers to explore multimodal compositions with multiple web-based applications (Kist, 2017).

Preservice Teachers Learning Teaching Dispositions. Preservice teachers have opportunities to use technology as a scaffolding tool in their development of specific dispositions for teaching, such as communication, collaboration, providing feedback, and reflection. For example, Keppell et al. (2006) designed a virtual learning community for preservice teachers to continually practice their feedback skills as they worked collaboratively on assignments. Other

preservice teachers have worked in concert to create a collective website as a product of their learning while also personally reflecting on their knowledge development through blog posts (Herrington et al., 2014). In a different study, preservice teachers watched videos recorded by their peers and provided feedback on a designated blog site. They repeated this cycle multiple times, and results suggest that they gained confidence in their presentation styles and modes of communication (Bower et al., 2011). These examples show how preservice teachers can use multiple digital tools to support collective and multi-step disposition development processes.

Peer Learning with Technology

The social aspect of learning with technology aligns with the sociocultural framework for learning through participation undergirding this dissertation. It follows then that preservice teachers can gain skills and dispositions and can see themselves as technology users as they collaborate with their peers. This work can occur in communities of learners dictated by coursework and by peers based on their interests and learning needs (Foulger et al., 2008; Graham, 2008). However, not all preservice teacher groups are the same, and the technical experiences and knowledge of the members can shape the group dynamics in supportive (Mukama, 2010) or challenging ways (Tondeur et al., 2011). Group assignments can result in tensions, with some preservice teachers feeling frustrated by the new technologies. Yet, the research results also speak to the power of giving students a choice in the outcomes of their learning (Herrington et al., 2014).

Preservice Teachers Learning How to Teach with Technology

To prepare future teachers to educate students for their digital lives, there have been increasing levels of technology used in K-12 schools (Rehmant & Bailey, 2014) and in TEPs (U.S. Department of Education's Office of Educational Technology, 2016). However, simply

adding more technology into formal learning spaces is not necessarily the answer. Educational stakeholders need to pay close attention to what supports students and preservice teachers receive and the opportunities they have to practice using the technology available to them (Admirall et al., 2017). Prior research suggests that the way preservice teachers are prepared to integrate technology into their teaching practices is complicated and has many overlapping elements such as prior experiences, access to digital tools, mentoring, instructional support, and institutional leadership (Røkenes & Krumsvik, 2014; Tondeur et al., 2019).

The Impact of Educational Technology Classes

Even though there is an upward trend of integrating technology into TEP coursework, much of the focused technical instruction occurs during stand-alone educational technology courses (Polly et al., 2010). Within these courses, studies have shown that a comprehensive approach with multiple opportunities to read, discuss, observe, and practice using technology can help shape preservice teachers' dispositions, skills, and practices (Ertmer & Ottenreit-Leftwich, 2010; Buss & Fulton, 2012; Admirall et al. 2017). In many cases, teacher educators use the Technological Pedagogical and Content Knowledge (TPACK) framework[3] (Mishra & Koehler, 2006) as guiding principles in their course designs and as content to teach students (e.g., Bush and Fulton, 2012; Voogt et al., 2012). However, TPACK has been criticized for being formulaic and not encouraging creativity in teachers or students (Mishra et al., 2015). As a result, some take up the Connected Learning framework (Ito et al., 2013) to provide learning experiences that challenge preservice teachers to rethink their understanding of their subject area in terms of

[3] The TPACK framework posits that teachers can develop knowledge for teaching with technology based on dynamic combinations of their technical, subject area, and pedagogical knowledge.

digital literacies and equity (Mirra, 2020) and provide a more contextualized learning experience (Herrington et al., 2014) that offers increased choices, support, and time to explore new technologies (Lohnes Watulak, 2018).

The Impact of External and Internal Contextual Factors

Tonduer et al. (2012) propose a visualization model consisting of concentric circles to represent the external and internal influences on preservice teachers' ability to teach with technology. Their two broadest circles depict the powerful role that institutions like universities play in shaping preservice teachers' use of technology. While the role of institutions tends to be left out of the discussion (Pettersson, 2008), universities and schools can be enabling or constraining factors in terms of technology access (Mukama, 2010) and the level of training offered to staff and other leaders (Tondeur et al., 2019). These two settings are composed of influential people, variable access levels, and support for using technology in teaching and learning. I have previously discussed the influence of university settings and teacher educators, now I add a layer to the conversation by highlighting the impact of school placements, mentor teachers, and pupils.

The Role of Student Teaching Placements

Student teaching placement schools and classrooms are influential factors that can support or hinder preservice teachers' use of technology in their teaching. The most notable elements in these settings are the availability of technology and the level of modeling and support provided by mentor teachers (Tonduer et al., 2012). Research suggests that preservice teachers are more likely to integrate technology into their teaching when they have access to reliable devices, WIFI signals, and applications. Furthermore, preservice teachers benefit from opportunities in their student teaching classrooms to implement technology-integrated lessons

that they practiced in their university courses (Admirall et al., 2017). However, when there is a lack of working technology in student teaching schools, preservice teachers either do not have the opportunity to practice or decide that it is not worth the effort (Foulger et al., 2012).

Mentor teachers also play a significant role in providing authentic examples and supporting preservice teachers (Sadaf et al., 2016). Some preservice teachers prefer to partner with their mentor teachers in solving problems of practice with technology over passively observing (Admirall et al., 2017). These researchers also suggest that preservice teachers can benefit from K-12 student feedback on the implementation of technology into their teaching (Sadaf et al., 2016; Admiral et al., 2017). It is clear from the research cited above that school settings are influential sites of practice where multiple actors shape what and how preservice teachers can use technology in terms of availability and mentorship.

Preservice Teachers' Personal Factors

Preservice teachers' prior histories and current dispositions influence their intentions to use technology and execution of those intentions in their student teaching classrooms. Previous evidence suggests that preservice teachers are more likely to use technology in their student teaching placements if they have positive beliefs and attitudes toward the value of technology in teaching and learning (Sadaf et al., 2016). In addition to their conceptions of the usefulness of technology, preservice teachers who believe they have the technical skills, self-efficacy, and prior training to use technology tend to implement it in their student teaching classrooms (Chen, 2010).

Muddling these findings is a more recent avenue of research in which subject areas (i.e., science, English language arts, and mathematics) seem to have different levels of influence on teachers' technology use as seen in the results of Howard et al.'s (2015) study where science

teachers use technology more than language arts and mathematics teachers. Still, more research is needed to better understand differences in beliefs among subject areas. One ongoing question that is investigated in this body of research is preservice teachers' understanding of how digital technology is changing their subject areas. For example, language arts preservice teachers have struggled to adapt to and adopt novel digital and multimodal literacies in their student teaching placements (Hundley & Holbrook, 2013; Kist, 2017). In these cases, preservice teachers' preconceptions about legitimate forms of literacy play an important role in shaping their practices with and without technology.

Preservice teachers cite multiple reasons for not integrating technology into their student teaching classrooms. They are concerned that using digital tools will have adverse effects on student learning, such as distracting students (Li et al., 2015), facilitating cheating, and equity issues stemming from disparities in access (Thomas & Bannon, 2013). Preservice teachers also discuss excluding technology in their teaching because they lack the time to prepare their students for using web-based technology like blogs (Boulton & Hramiak, 2014). Preservice teachers who present negative attitudes toward using technology also may have difficulty engaging students in meaningful technology-infused learning (Greene, 2011). To help ameliorate some of these factors, some researchers suggest that teacher educators work with preservice teachers to develop new visions for and experiences of teaching with technology and create plans to support their use of technology upon graduation (Ertmer & Ottenbreit-Leftwich, 2010).

Chapter Summary

Throughout this chapter, I have highlighted instances where research on preservice teacher learning and technology connects to broader phenomena explored in teacher education. Thus, the insight we gain from studying how preservice teachers use technology can provide us

with a more nuanced understanding of preservice teacher learning within and across their TEP settings. I present Figure 3 to illustrate the connections between the main concepts in Chapters 2 and 3. I use a familiar hexagonal layout to provide consistency and clear links between the concepts. The ideas from Chapter 2 are on the inside edge of the hexagon, and the contributions from Chapter 3 are in larger bullet points.

Figure 3. A visualization of the connections between concepts explored in Chapters 2 and 3.

The top **maroon** hexagon adds a layer of nuance to our understanding of preservice teachers' histories by considering their prior digital lives. I argued that we need to include preservice teachers' diverse media ecologies and dispositions for using technology to gain a

more comprehensive understanding of how to support their learning. In response, my dissertation explores my participants' digital lives before and during their TEP and investigates the meaningful people, practices, interests, and emotions associated with digital technology.

Next, Chapter 3 helps expand our knowledge of preservice teacher learning through social interactions by adding the element of digital technology. The research I have discussed in Chapter 3 suggests that teacher educators, peers, and students are relevant social actors in teacher learning settings. Members of these groups can provide preservice teachers with a range of supportive or constraining opportunities to access and use technology. These groups of people are also considered part of the interconnected contextual factors (**teal** hexagon) in teacher learning settings. Chapter 3 provides a technology lens through which to examine contextual factors like district leadership, access, teacher educators as role models, and time needed to plan.

The **navy** and **gray** hexagons to the left begin to untangle the complicated teacher learning process that occurs over time and includes multiple bodies of knowledge and skills. Chapter 3 helps refine our understanding of this topic by providing details about how preservice teachers can grow in their uses of technology throughout the stages of their careers when placed in supportive environments with access and mentorship. Research in this chapter also provides examples of how teacher educators can design instruction for preservice teachers to learn specific information using technology, such as learning theories and dispositions.

The last hexagon (**gold**) expounds on what we know about preservice teachers' efforts to contribute to their learning communities and exercise their agency with technology. While this area of research is developing, Chapter 3 provides some examples of preservice teachers' leveraging their knowledge and skills for using technology to facilitate their contributions to group projects. When evaluating preservice teachers' actions with technology, we must consider

the role of contextual factors such as teacher educator support and access to technology. In order to study how preservice teachers exercise agency in their learning with technology, I designed this dissertation to investigate the contextual factors present in their learning environments and how they navigated the different social dimensions of each setting.

CHAPTER 4

A Sociocultural Perspective on Preservice Teacher Learning

In this dissertation, I weave together specific approaches in sociocultural theories of learning and development to support my understanding of preservice teacher learning. I begin by focusing on the ecological dimensions of learning, drawing attention to the interconnected nature of immediate and more distant settings available in TEPs. I then detail the influential features of those settings, paying particular attention to their historical, cultural, and social dimensions. Next, I describe how these interconnected sociocultural features mediate preservice teacher participation in particular communities of practice. I then present the case for preservice teacher learning through participation as an ongoing process of making meaning, actions, and developing a sense of belonging. I then explore the role of cultural tools in mediating preservice teachers' cognitive processing and physical actions. I then turn to theoretical models for explaining how preservice teachers' contributions to their communities of practice are examples of preservice teacher agency with mediated, temporal, relational, and transformative dimensions. I conclude the chapter by presenting a graphic that illustrates my approach to studying the participants in dissertation.

Ecological Dimensions

Preservice teacher development can be understood as situated within meaningful social and cultural-historical contexts (Fishman et al., 2014). Simply put, learning does not occur in and across physical or virtual spaces that are isolated from outside influences. Instead, it happens in social settings shaped by various political, economic, cultural, and historical influences. Accordingly, Bronfenbrenner's (1977, 1979) ecological theory of human development posits an interconnected systems approach for understanding the interplay between social environments

and human growth. In doing so, he proposes an interconnected set of influential social systems that range from the most immediate and visible microsystems (i.e., family and school) to broader and less visible macrosystems (i.e., economic and political forces). He describes the ecological environment of individuals' development as a "nested arrangement of concentric structures, each contained within the next" (1979, p. 22). This metaphor illustrates the interactions between dynamic systems and persons (Tharp & Gallimore, 1998). However, the nesting comparison may limit our understanding of relations between social, cultural, and historical settings (Rogoff, 2003). It may be the case that the relationship between the settings is less like nesting Russian dolls with predetermined concrete forms and more like a networked map with overlapping social influences (Neal & Neal, 2013).

Applying An Ecological Model to Teacher Education Programs

My interest in Bronfenbrenner's theory of ecological development lies in his attention to the immediate and more distant systems that influence a learner's sociocultural environment. Likewise, Wideen et al. (1998) argue that TEPs and beginning teachers do not function in isolation. Thus, we must attend to the multiple settings available in preservice teacher learning: ones that are at times interconnected and other times disjointed, depending on personal, cultural, and institutional histories (Feiman-Nemser, 1985; Grossman et al., 1999; Britzman, 2003; Zeichner, 2010).

Drawing from Bronfenbrenner's theory, I propose that the preservice teachers included in this study learn within immediate microsystems consisting of settings operating in and outside of their TEP. These settings include physical structures like school buildings and digital spaces such as online coursework. They also include elements such as objects, activities, roles, people, and relationships that influence, and are in turn influenced, by a developing person (Bronfenbrenner,

1981). Applied to preservice teachers, these microsystems can provide a range of activities that enable different interactions, roles, and resources (van Huizen et al., 2005). I identify three microsystem settings in this study: (1) the university campus/teacher education program, (2) student teaching school, and (3) outside of school settings (i.e., home and neighborhoods). In other words, these immediate settings are "where students live their daily lives" (Leonard, 2011).

However, these microsystems do not exist alone, a central component to Bronfenbrenner's theory is the mesosystem, or interconnections between microsystem settings. The interactions between the microsystem's immediate environments can be activated when a person transitions into a new setting, such as beginning a TEP (Bronfenbrenner, 1981). Thus, the environment for preservice teacher learning is a dynamic space composed of overlapping local settings and elements.

I wish to complicate this picture of learning by considering more distant political, economic, and social contexts, such as the exosystem and macrosystem (Bronfenbrenner, 1979). These additional systems are significant because they exert varying amounts of influence on "overarching patterns of ideology and organization of the social institutions" (Bronfenbrenner, 1981, p. 8) found in the aforementioned settings explored in this study. While preservice teachers are not necessarily considered as active participants in exosystem and macrosystem contexts, taking an ecological approach to learning considers these systems as significant factors influencing the sociocultural conditions of their more immediate contexts. In terms of this study, the exosystem can include state-level politics and regulations around teacher certification, district-level decisions about technology available in schools, and factors related to mentor teachers' work, to name a few examples. And the macrosystem can includes nationalized approaches to schooling and teacher preparation. Altogether, taking an ecological approach

highlights the ever-present influences exerted by local and more distant systems on preservice teacher learning.

Sociocultural Features of Our Social World

I draw from a long tradition of sociocultural research demonstrating that development and learning occur through participation in our social world (Wenger, 1998). In this view, our social world is understood to be continually shaped by historical, cultural, and social dimensions (Rogoff, 2003) and there is an inseparable relationships between individuals and their social communities (Gee, 2008). These relationships are predicated on the notion that individuals' participation in social communities is guided by available cultural-historical resources. In further discussing cultural resources, Vygotsky argues that individuals' mental functioning is always mediated by psychological tools such as language (Wertsch, 2007). Therefore, "individual and cultural processes are *mutually constituting* rather than defined separately from each other" (Rogoff, 2003, p.51). This interconnected process makes it possible to reflect on the embedded nature of preservice teacher learning within the contexts operating within TEPs. In this way, preservice teachers use accessible cultural tools to undergird their mental processing and participation and, in turn, contribute to their shared activity (Jahreie & Ottesen, 2010).

Learning Through Participation

I apply Wenger's (1998) social theory of learning to understand how preservice teachers learn during their TEPs. As such, learning is conceived as multidimensional participation, in which an individual learns through practice, meaning-making, and community belonging (Wenger, 1998). These engagements can be fostered through multiple social and personal capacities such as talking, thinking, doing, and feeling. In this way, learning can be conceived as constituting social, cognitive, and emotional dimensions (Herrenkohl & Mertl, 2010). Thus, a

sociocultural and situated approach to preservice teacher education means that learning can occur through a change in knowledge (McNicholl & Childs, 2010), managing social experiences, utilizing cultural tools, and seeing oneself as a teacher (Edwards, 2010). In essence, preservice teachers learn through multifaceted modes of participation, mediated by cultural and historical dimensions within and across the social settings of their TEPs.

Cultural Tools Mediating Participation

Given that our cognition and actions are facilitated in part by culturally produced tools such as language, sign systems, and physical tools, our engagement with the world is always mediated. For Wertsch (2007), Vygotsky's research underlines how we interact with the world indirectly, because historically produced signs and artifacts implicitly and explicitly mediate our lives. Cole (1995) employs the concept of *the artifact* to more comprehensively capture the complexity of the mediation process. He defines artifacts as an inseparable component of a given sociocultural context, noting: "artifacts do not exist in isolation. Rather, they are interwoven with each other and the social lives of the human beings they mediate in a seemingly infinite variety of ways" (1995, p.194). In further describing artifacts, Cole takes up Wartofsky's (1979) three-part definition of primary, secondary, and tertiary artifacts, with the most relevant tier for this dissertation being *primary artifacts*. This category of artifacts closely aligns with the definition of tools as objects used in the production of activities. In his research, Cole suggests primary artifacts can be electronic devices such as computers and the networks that support their use. Thus, for the purposes of this dissertation, I identify the electronic devices and digital programs available to preservice teachers as primary artifacts: ones they use to mediate some aspects of their participation in TEPs.

The Development of Preservice Teacher Communities of Practice

Thus far, I have presented a theory of preservice teacher learning as socially situated and mediated participation. I will now expand this theory by employing Wenger's (1998) perspectives around communities of practice. Taking this approach allows for a nuanced understanding of preservice teacher participation: one occurring through mediated interactions and sense-making, within the context of the formation and continuation of communities of practice. It also shifts the focus from the individual to how they learn through engagement with others in the production of a community. Wenger begins this endeavor by connecting the concepts of practice and community; practice occurs when "people engage in actions whose meanings they negotiate with one another" (1998, p.73). This socially contingent view of practice highlights its situated nature, in which a group of people comes together to develop and engage in shared practices. In other words, individuals participate through developing and sustaining practices that hold a community together. The preservice teachers that made up the 2018-19 cohort in this dissertation are not automatically members of a community of practice, based solely on physical proximity to each other. Instead, they form communities of practice when they interact—in myriad ways— to build a shared practice, based around the joint endeavor of learning how to teach.

The Creation of Shared Practice

As described by Wenger (1998), a community of practice's joint enterprise is an ongoing process that emerges as group members "negotiate their response to their situation" (p. 77). This means that group members, alongside external and internal influences, develop a shared practice based on their responses to the task presented before them. Their reactions can include procedural steps and interpersonal relationships in which they hold each other accountable for

community membership. I apply this concept of a joint enterprise to guide my understanding of how preservice teachers develop a shared practice as they progress through their TEP.

Learning Through Meaning-making, Participation, and Transformation

As a multidimensional process, preservice teacher learning happens not just through social interactions, but through the meaning one makes around lived experiences. Wenger (1998) argues that the process of negotiating meaning is central to theorizing about learning through practice. By this, he means that our participation in social communities does not occur as isolated actions. Instead, we work to make sense of our experiences through our historically-based understanding of the world and how it compares to our present circumstances. Guiding this negotiation of meaning is our own "personal history of participation" (Wenger, 1998, p. 153). The process of negotiating meaning includes not only one's prior history and knowledge but one's current levels of participation in combination with the reification of one's ideas.

Increasing the intensity of a learner's participation can occur as they take up and contribute to a community through engagement in social relationships, use tools in different activities, create discourse, and ultimately form personal identities (Lave & Wenger, 1991). Wenger (1998) complicates this view of development by including both acts of participation and non-participation. He argues that in addition to understanding ourselves by the practices and communities in which we participate, we also need to account for the practices we do not or are not allowed to participate in. This situated view of identity suggests that developing a sense of belonging to a community includes transforming a role from less to more consequential and recognizing one's place in the group by other members (Lave & Wenger, 1991).

I have built a case for how preservice teacher learning can be framed through the lens of mediated participation, and subsequent sense-making and belonging within communities of

practice. However, a sociocultural perspective of learning through participation must also consider how individuals shape and contribute to their social groups' cultural practices (Rogoff, 2003). To account for this, I will now turn to the concept of agency in preservice teacher learning.

A Perspective on Preservice Teacher Agency

I employ a sociocultural approach to agency to theorize how preservice teachers use cultural tools (e.g., digital technology) to support their learning in ways that align or differ from the materials and methods presented in their TEP. In a broad sense, I understand preservice teacher agency to be a facilitated process in which individuals use their prior histories and current understanding of their situations to gauge their capacity to intentionally act, using available cultural resources in a given social context. It follows, then, that individuals can be enabled or restricted by their social contexts (Priestley et al., 2015), and that their actions can fall on a spectrum from complying to resisting the practices and norms of the group in which they are participating (Gresalfi, Marin, Hand & Greeno, 2009). Acting against this backdrop, individuals are driven in part by their capacities to imagine alternative solutions and formulate goals to guide their agency (Emirbayer & Mische, 1998).

Defining Agency

In describing the process of agency, researchers have attached different verbs to the term, such as "achieve" (Biesta & Tedder, 2007), "work" (Lipponen & Kumpulainen, 2001), and "exercise" (Ahearn, 1999; Bandura, 2000). To my mind, "achieve" and "work" convey an endpoint to agentic action. Moving forward, I will refer to agency as a *process* that is exercised to connote its ongoing nature imbued with meaning and shaped by practice. Furthermore, agency is not something that belongs to the individual (Wertsch et al., 1993; Biesta & Tedder, 2007); it

is instead a situated process of cognitive functioning, and resulting actions mediated by contextually-based resources and social interactions (Priestley et al., 2015). While it is difficult to tease apart its constitutive elements, I will describe agency in terms of how it is mediated, temporal, relational, and transformative.

Temporal qualities. The temporal qualities of the agency process highlight how it is embedded within the progression of time. Individuals' mediated understanding of their range of actions is situated within a social world impacted by past, present, and future dimensions. In particular, agency is a "temporally embedded process of social engagement, informed by the past...oriented toward the future...and acted out in the present" (Emirbayer & Mische, 1998, p.963). By this, the authors mean that individuals act in the present based in part on how they make sense of their prior histories, imaginings of the future, and current circumstances. While these dimensions are listed in order here, that is not to say that they play out in equal proportion when it comes to individual agency. Rather, over the course of their lives, individuals develop different configurations of past/present/future orientations to in part shape their agentic actions (Biesta & Tedder, 2007). Applied to preservice teachers, Priestly et al. (2015) suggest that their past experiences are developed as students in compulsory education, during TEPs, and in their current contexts. The authors argue that these past schooling experiences need to be reframed so preservice teachers can understand them less as skills and more as points of reflection to be used in part to make future decisions.

Relational aspects of agency. Interactions with other people are considered as part of the cultural resources that mediate individuals' abilities to act. Lipponen & Kumpulainen (2001) suggest that agency is "embedded in social groups and emerges in collaborative networks" (p. 818). Thus, individuals' agency can play out on a social plane, where they understand their

abilities to act in relation to others' thoughts and actions. Edwards (2005) suggests that relational agency can be understood as "purposeful practice with others" (p. 162). In doing so, she highlights the relational dimension of agency in which one has a capacity to consider others' thoughts and actions as a resource for planning actions for oneself. Also, Edwards (2010) suggests that relational agency includes the capacity and desire to work with others, identifying and solving problems within a local practice. The key implication here is the significant role that other people (i.e., university faculty, mentor teachers, cohort peers, students, etc.) and their knowledge (i.e., pedagogical) play in creating opportunities for preservice teachers to exercise agency in their TEP. The relational aspect of agency highlights how the significant people listed above also come with expertise that can support the preservice teachers' understanding and actions as agentic participants.

Transformative dimensions of agency. Agency has been discussed in terms of individuals, but it is also possible for collective agency to occur when groups of people work in shared spaces such as workplaces to transform their practices (Haapasaari, Engeström & Kerosu, 2014). Transformative agency accounts for individuals' and groups' desires to diverge from traditional patterns of action and actively work to transform their practices or situations (Virkkunen, 2006). As I understand it, transformative agency is a way for people to actively critique— and work to change—current situations. This dimension of agency is a crucial component to understanding how preservice teachers perceive and perform a range of mediated actions as part of their TEPs. For example, preservice teachers have exercised agency in transformative ways to challenge neoliberal approaches to curriculum use, advocate for more critical multicultural approaches (Liggett, 2010), and add to their departments' knowledge base (McNicholl & Childs, 2010). Thus, preservice teachers can exercise agency in transformative

ways, approaching the complexities of contemporary classrooms through their active engagement with, and responses to, current classroom contexts (Brevik et al., 2019) while also asking questions about the cultural-historical practices of teaching and learning (Edwards, 2010).

A Visual Model for Preservice Teacher Learning

I conclude this chapter by presenting a model illustrating the framework for preservice teacher learning used throughout this dissertation. I built this model from my understanding of the theories presented in this chapter. The model (see Figure 4) represents my interpretation of preservice teacher learning, using artistic license. It, therefore, does not constitute an exact or scientific representation of such learning processes.

I created Figure 4 using a series of hexagons to represent the ecological and sociocultural dimensions of preservice teacher learning. The composition of the hexagons illustrate the interconnected nature of the broader and more immediate influences on learning. The top black hexagon represents the more distant ecological features such as the exo and macro systems (e.g., national and state approaches to education) and the bottom gray hexagon showcases the sociocultural features (e.g., historical, cultural, and social dimensions that shape the resources, practices, knowledge, and tools available to preservice teachers). These two hexagons overlap to create the structure that supports the smaller hexagons representing the micro and mesosystems in the middle of the figure.

The maroon hexagon in the middle left of the figure references preservice teachers' prior histories that include their past experiences, dispositions, and knowledge. Just to the right, a purple hexagon represents the TEP with its multiple settings, people, knowledge, practices, and tools. To the far right, the teal hexagon illustrates the outside of school spaces that the preservice teachers inhabit. The three middle hexagons overlap to support the centermost hexagon that

shows the multifaceted communities of practice in which preservice teachers learn through mediated participation and sense-making. The watercolor paints—maroon, purple and teal—mix, overlap, and create new colors, portraying the dynamic relationship between preservice teachers' prior histories and current circumstances.

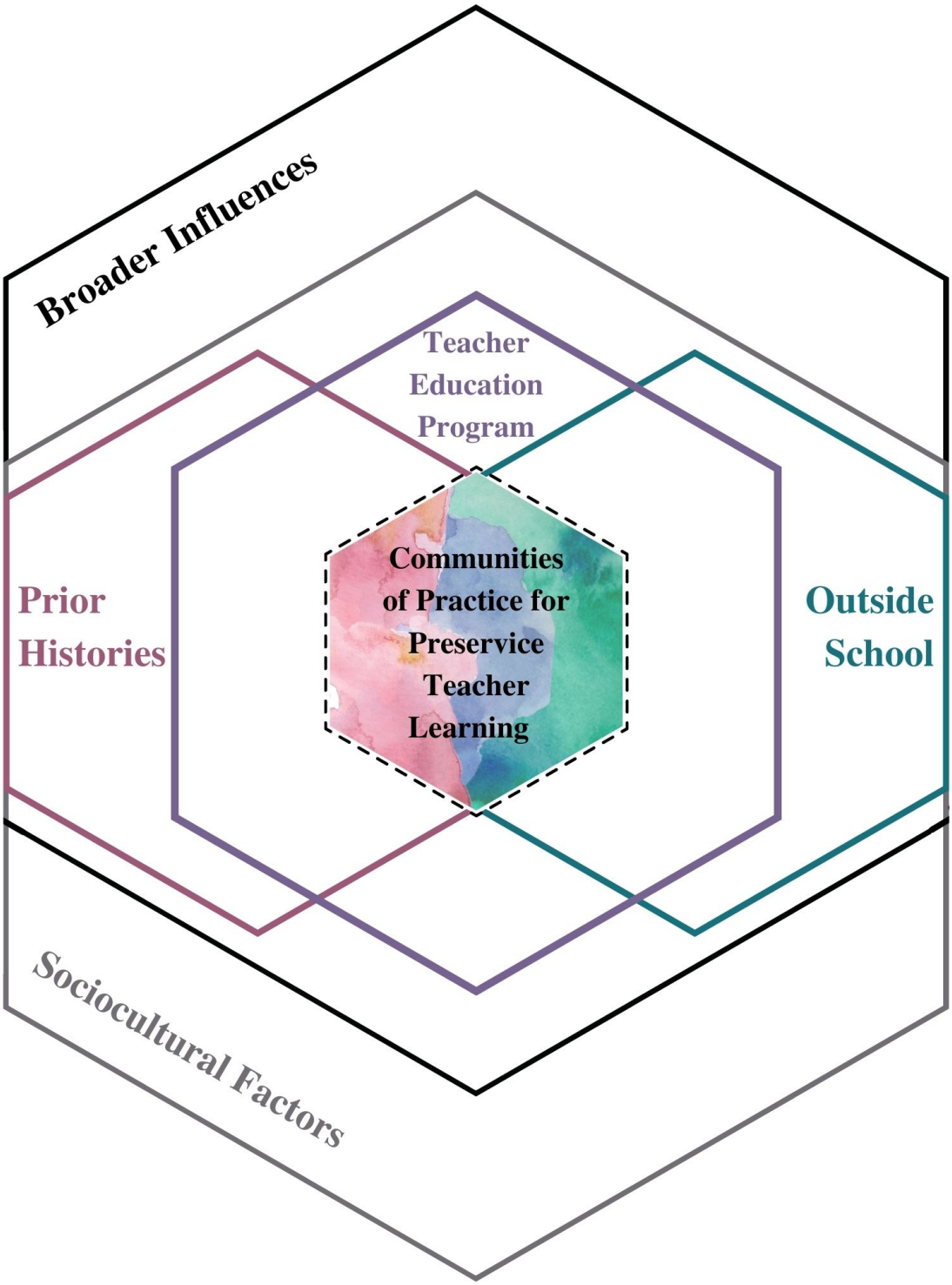


Figure 4. A theoretical model for preservice teacher learning in this dissertation.

CHAPTER 5

Methodology Introduction

In this chapter, I describe the methodological approach I use to guide my research. This dissertation is a one-year qualitative case study utilizing multimodal, interview, and observational data sources to research how six secondary preservice teachers use technology throughout their TEP. I begin this chapter by situating my study design within the history of qualitative research and outline how current research methods for studying digital technology impact my study design. The second half of the chapter provides details about my study's participants, contexts, and data collection procedures. I conclude the chapter with a description of my data analysis process.

Foundations of Qualitative Research

Taking a qualitative approach allows me to study *how* preservice teachers make sense of their learning with technology. Qualitative methodologies aid researchers in understanding "how people interpret their experiences, how they construct their worlds, and the meaning they attribute to their experiences" (Merriam & Tisdell, 2016, p.15). Employing these tenets of qualitative research, participants can provide insights into their knowledge and practices as studied in everyday contexts (Flick, 2009). In addition, using qualitative methods allows for the investigation of preservice teachers' learning in ways that make visible the "invisibility of everyday life" (Erickson, 1986, p.121). I take a qualitative approach because it allowed me to study preservice teachers' uses of technologies that have become increasingly integrated into contemporary life and are becoming invisible (Weber & Mitchell, 1996).

Applying a Case Study Approach

To effectively study preservice teachers' learning with technology, I employed a case study method, which allowed for both in-depth study of a small number of participants and sufficient attention to the complexity of each participant's experience (Ragin, 1999; Merriam & Tisdell, 2016). I defined the duration of the case as one year (March 2018-June 2019), with three main settings, the university campus, local schools, and outside of school spaces. While the TEP and participants' schools helped establish case boundaries, I also understood the cases as embedded within a larger system providing space for interactions within and across the participants' experiences. (Stake, 2003).

Within the case study method, there are important contextual features to consider. I used Yin's (2006) notion of subtopics to account for "key contextual conditions" (p.112), such as university courses, student teaching schools, teacher educators, peers, and students to name a few. Such contextual features enrich my descriptions of the myriad factors enabling and constraining preservice teacher learning with digital technology.

Qualitative Research in Teacher Education

Researchers in the field of teacher education have a lengthy history of studying teacher learning using qualitative methods that honor participants' experiences. For decades, the qualitative methods included preservice and in-service teacher interviews, observations, and collection of artifacts (Lortie, 1975; Tabachnick & Zeichner, 1986; Britzman, 2003; Ellis, 2010). As such, qualitative research designs with multiple forms of data can produce interpretations of teacher learning within specific settings and over time (Ellis, 2010). In order to better understand the experiences of preservice teachers, researchers include other teacher education stakeholders' voices such as field supervisors (Windschitl et al., 2020). In addition, I draw on a long tradition

of longitudinal methods to study teacher learning as occurring overtime and in relation to the complex contextual factors present in schools (Grossman et al., 1999; Anderson & Stillman, 2011; Hebard, 2016).

From these studies, I learned that with preservice teachers and teacher educators, multiple methods of data collected over a longer period of time are helpful for capturing the complexities of learning to teach. I therefore wove together observations, semi-structured interviews, and visually based activities for each preservice teacher to triangulate my data.

Methods for Studying Teacher Education & Technology

To study preservice teachers and technology, researchers use various methodologies. When researchers want to learn about preservice teachers' uses of technology before entering their TEP, online surveys are a common methodology, as seen in studies by Lei (2009), Kumar and Vigil (2011), and Fluck and Dowden (2013). Researchers also collect multiple data points to understand what preservice teachers are learning about technology, such as questionnaires, student artifacts, lesson plans and reflections, and teacher educators' instructional materials (Rehmat & Bailey 2104; Admiraal et al., 2017; Instefjord & Munthe, 2017). Researchers have also employed creative measures such as 'pre' and 'post' drawings to understand how the participants see themselves as technology users (Funkhouser & Mouza, 2013). The methodological approaches utilized in these studies highlight the importance of having both interview data and artifacts from the participants. I therefore designed my data-collection process to include survey data, recurring interviews, student work such as assignments, and visual artifacts created over time by the participants.

My Interest in Visual & Digital Methodologies

In 2016–2017, I co-designed and implemented a pilot study with a graduate school colleague, Adam Bell, and faculty advisor, Katie Headrick Taylor. From this pilot study, I learned that at times during our interviews, it was difficult for the participants to remember examples of using technology in their TEP, which led me to consider how I might collect data that more closely reflects participants' everyday experiences with technology. I looked to studies that used visual methodologies and digital ethnographic approaches for inspiration.

Broadly, visual methodologies are becoming more central to qualitative research (Pink, 2012) and can engage participants in creating visual modes of representation such as drawings, photographs, and videos (Mitchell, 2011). Specifically, digital ethnography, can be utilized in multiple ways to study "how digital media are part of people's everyday worlds" (Pink et al., 2016, p10). In terms of my research questions, the principles from digital ethnography have helped me take a more non-digital-centric approach as I explored emerging ways in which technology populates a larger ecosystem of settings, activities, and relationships (Pink et al., 2016). There are also specific data collection procedures used in visual methodologies and digital ethnographic studies that influenced my study design. In particular, Pink et al. (2016) describe studies that use multiple home visits—with reenactments, video recordings, and photographic documentation of technology use—to explore people's digital rhythms. The authors describe how these studies were able to research routine practices embedded in their participants' daily lives. I took inspiration from Pink et al.'s data collection procedures, and I designed a portion of the study to include participant photographs of their everyday digital practices.

Study Design

Having situated my dissertation in the traditions of qualitative and digital research, I next provide further detail about my study's participants, settings, and data collection procedures. I begin by chronicling the participant selection process and then provide short introductions of each preservice teacher. Following this, I describe the study settings, with attention to university, school, and home spaces and then go on to define my data collection procedures. Finally, I conclude the chapter with a description of my data analysis process.

Selecting Study Participants

The participants in my study were all enrolled in a secondary TEP at a university in the Pacific Northwest. To select participants, I designed an online Qualtrics survey to collect information about the individual preservice teachers' digital technology uses, as well as the overall trends in the cohort (Berends, 2006). When designing my survey, I revisited the survey used in the pilot study, which was partially informed by Mishra and Koehler's technology survey (Schmidt et al., 2009). I condensed the pilot survey to a more manageable length, including questions about how the preservice teachers used technology in their personal, educational, and professional lives. The content of each question dictated whether the question was in Likert scale, multiple-choice, or short answer format. For example, the Likert scale was used for questions relating to hours of mobile phone use, while a short answer format was used for questions about how the participants used technology in high school. The complete survey is listed in Appendix A.

Survey Distribution and Analysis

I distributed the online survey link during the TEP cohort's orientation week on campus. The TEP director afforded me 15 minutes to introduce myself and my role as the instructor for

their upcoming technology seminar course. I described the survey as a method to better understand the cohort's experiences with technology to help inform our course and to select participants for my dissertation study. I stated that it was optional for the preservice teachers to participate in the survey. Of the 62 preservice teachers present, 59 took the survey and three declined. I then reviewed each participant's answers, coding them by level of technology use as of *low*, *medium*, or *high* use according to the following scale: *low use*—around 0–10 hours per week with few devices listed; *medium use*—around 20 hours per week with some devices listed; and *high use*—around 30 hours per week and many devices used. Of the 59 preservice teachers who completed the survey, 39% were *high* technology users, 44% *medium*, and 17% *low* (see Figure 5).

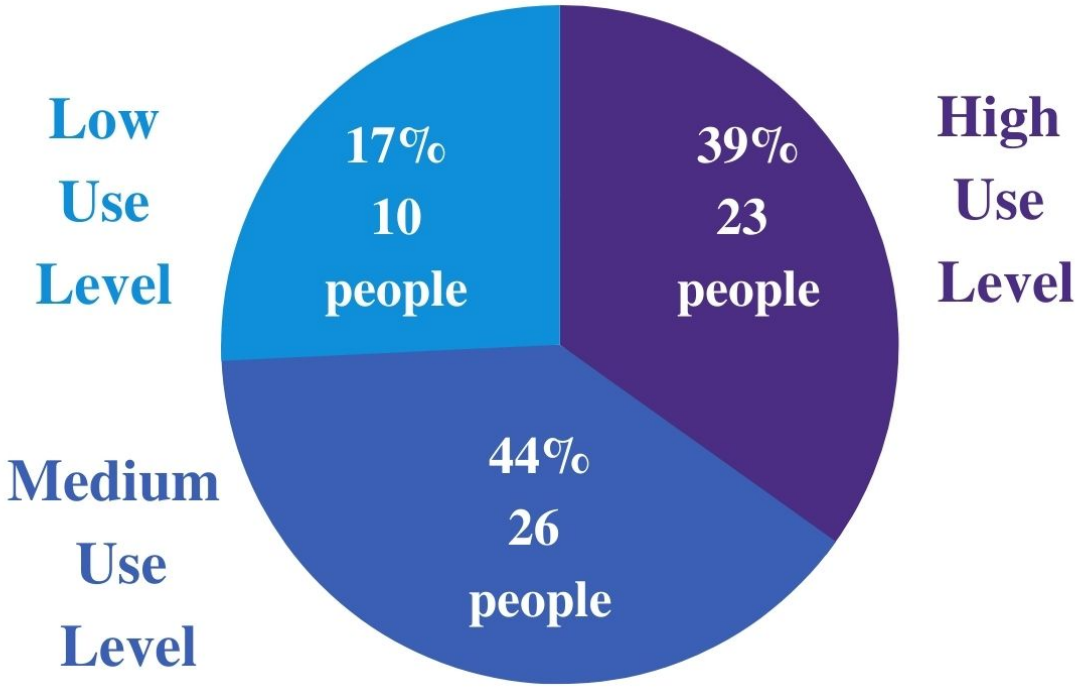


Figure 5. Percentage breakdown of the low, medium, and high technology users in the cohort.

Based on this coding system, I then selected potential participants, aiming for a range of low-, medium-, and high-level technology users to represent a range of experiences throughout

the TEP (Gao et al., 2011). I emailed the list of candidates and invited them to a pizza lunch to learn about my study. I received no responses from preservice teachers in the "low" category. During the lunch, I introduced the survey idea to five preservice teachers in the high-use category and three in the medium level. Ultimately, all five of the high-level users consented to participate, and one preservice teacher in the medium group joined the study. These preservice teachers varied by subject-area focus, age, race, and gender identification. Figure 6 introduces the participants, in alphabetical order by their chosen pseudonyms, with their subject areas and age ranges. To further introduce the participants, I include photographs that I chose for each of them, which reflect my interpretations of our year of working together.

Participant Introduction

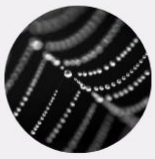
Name	Chloe	Dylan	Lark	Lauren	Natalie	Perl
Image						
Tech level	High	Medium	High	High	High	High
Subject area	Science	Social Studies	Science	Social Studies	Social Studies	Mathematics
Age range	23-36 yrs	27-32 yrs	23-26 yrs	27-32 yrs	18-22 yrs	27-32 yrs

Figure 6. Introductory information for each participant.

Introducing My Participants

During one of our interviews, the participants each filled out a demographics questionnaire. I used their exact responses with specific attention to capitalization and word

choice to introduce them here. Chloe, who identified as Asian and used she/her pronouns, was studying to be a science teacher. I selected Chloe because she self-reported high levels of technology use in terms of using multiple devices, creating media content, and having used technology extensively while completing her university coursework. The photograph I chose for Chloe represents her cheery disposition and combination of multiple life interests.

Next, Dylan was studying to be a social studies teacher, identified as White and as a genderqueer transmasculine person; Dylan used they/them pronouns. I selected Dylan for the study because they reported medium levels of technology use, had attended a technology-heavy high school, and regularly used technology to connect and share with other people. The photograph I chose for them represents Dylan's vibrant personality and beliefs.

Lark, who identified as a White cismale and used he/him pronouns, was studying to be a science teacher, and I selected him because he self-reported high levels of social media use, media creation, and sharing practices. The photograph I chose represents Lark's affinity towards nature and his bright outlook on life.

Lauren identified as a White female and used she/her pronouns. Lauren was studying to be a social studies teacher, and I selected her because she reported high use of technology outside of school and lower levels as a university student. The photograph I chose represents Lauren's friendly nature and her desire to form connections with her peers and colleagues.

Natalie identified as Asian [American] and cisfemale and used she/her pronouns. Natalie was also studying to be a social studies teacher, and I selected her because of her self-reported combination of high levels of computer use and low mobile phone use. She also cited using high levels of technology as a university student and regularly creating and sharing media content. The photograph I chose represents Natalie's interests in photography and editing.

Finally, Perl identified as a White female, used she/her pronouns, and was studying to be a mathematics teacher. I selected her because of her background in computer science, her high levels of technology use, and her blogging practices. The photograph I chose represents Perl's desire for structure in her personal and working life.

The six participants in this study were selected to provide a rich variety of prior experiences and current digital practices. Although I had no low-level technology users from the cohort to include, each participant was selected because they had self-reported using technology in ways that distinguished them from the rest of their cohort, thus providing me opportunities, in light of their shared and unique circumstances, to study the ways in which the participants leveraged their digital practices in their TEP.

I was also intentional about selecting participants from different subject areas, a methodological approach employed by other researchers (Ottenbreit-Leftwich et al., 2018). By looking across subject areas, I was able to observe specific methods courses as well as shared foundations courses attended by all cohort members. Along these lines, the range of subject areas gave me a more comprehensive data set to analyze in hopes of extending what we know about the phenomena of preservice teachers learning with technology.

Study Timeline and Multiple Settings

In line with traditions of studying teacher learning over time, I designed this dissertation as a one-year study that examines the participants' experiences before and during their TEP. In terms of their formal teacher preparation, I studied the participants from the beginning of their TEP in mid-March 2018 through their four quarters until graduation in March 2019. Throughout the duration of this dissertation's data collection phase, I followed the preservice teachers as they engaged with peers, teacher educators, and students in multiple settings.

Dissertation Settings

Longitudinal research on teacher learning also considers the multiple settings in TEPs such as university courses and student teaching placements (Feiman-Nemser, 2012; Jahreie & Ottesen, 2010). Therefore, this dissertation studies multiple formal educational settings, such as university courses and student teaching placements. Also, to expand my view of influential learning spaces, I drew on research about how children, young people, and adults use technology. These studies explore the multiple and sometimes overlapping settings of participants' lives, such as university learning spaces, classrooms, schools, homes, peer social spaces, on-the-move periods, and virtual spaces (Davis, 2011; Erstad, 2009; Watkins, 2009; Ito et al., 2010; Kalir, 2016; Garcia, 2017; Taylor, 2017). While not conflating young people in general with preservice teachers as a whole, I do suggest that this research provides a helpful foundation on which to explore the lives of both younger preservice teachers who have grown up in a digitally mediated world and those older preservice teachers who have incorporated and adapted to digital technologies throughout their lives. Thus, I include outside-of-school settings such as homes, peer social spaces, and time spent moving from location to location (in transit) as relevant spaces to study how preservice teachers use technology. Figure 7 illustrates the composition of the study's timeline and settings.

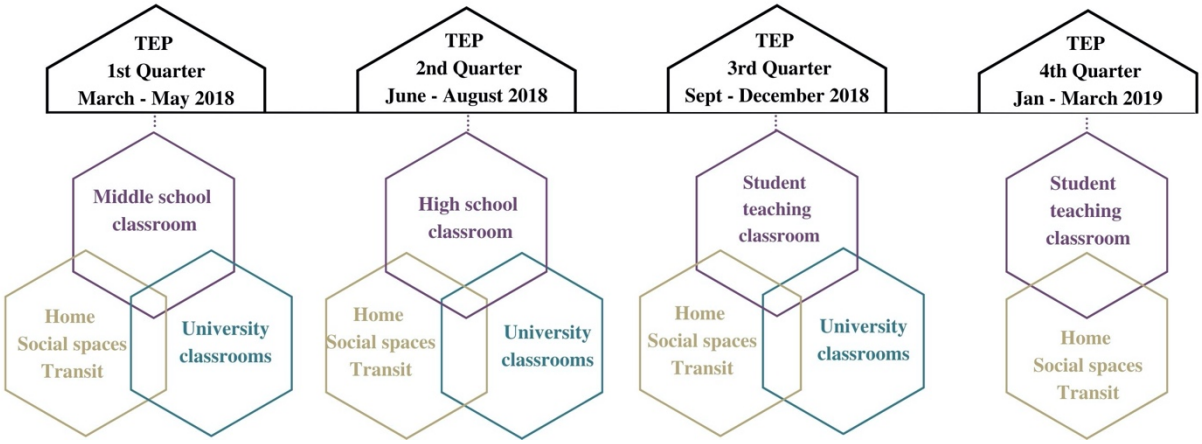


Figure 7. Study timeline with categories of settings.

My dissertation is composed of three main categories of settings: The first I call 'HOT,' for *home*, *other* social spaces, and in *transit*; second is *university settings* such as coursework and campus spaces; and third is *school-based* environments such as summer school and student teaching placements. It is important to note that I understand the settings listed above as comprised of material and virtual spaces (Pink et al., 2016). For example, university courses have the physical setting of the classroom with material objects such as tables, peers, and learning materials, as well as virtual spaces such as online collaboration tools (e.g., Google Docs) and the social media and text messaging services used throughout the class periods. Below, I provide descriptions of each setting category.

Category 1: HOT. This includes influential learning sites for preservice teachers' lives that are not formal school spaces. The acronym HOT stands for *home*, *other* social spaces, and *transit*, and I aim for this category to account for the multitude of settings that participants inhabited throughout their days and nights during the study's one-year span. Examples include time at home in their apartments, visits to parents' homes, bus rides to campus, bike rides to their school placements, virtual spaces, and extracurricular activities. The gold hexagons in Figure 7

represent the range of HOT settings in each of the four segments of the study design. These settings are studied throughout each quarter using interview questions and artifact analysis.

Category 2: University Campus and Coursework. This category includes multiple university campus-based settings used for preservice teacher learning, including formal coursework (e.g., methods, learning theory, assessment, technology, and other courses required by the TEP), as well as the library and virtual spaces. University courses were assessed during the spring, summer, and fall quarters through observations and interview questions. The teal hexagons represent university-based settings.

Category 3: School-based Settings. This category is composed of classroom-based and virtual spaces used by the participants during their TEP. To begin, the participants were placed in various middle and high school classrooms to observe and co-teach with different mentor teachers. In the spring quarter, the participants were placed in middle school classrooms primarily for observations. In the summer quarter, some of the cohort's university coursework was embedded in a local summer high school program where the participants worked in small groups to plan and implement daily lessons. In the fall and winter quarters, the participants were in student-teaching classrooms with mentors. To assess these settings, I observed the participants in their summer-school and student-teaching classrooms then asked follow-up questions during our interviews. I also analyzed the preservice teachers' artifacts for information about their school-based settings. The school-based settings are represented in Figure 7 by purple hexagons.

Data Collection Procedures

The qualitative approach to this study included multiple sources of data to gain a deeper understanding of how participants made sense of their learning experiences (Merriam & Tisdell,

2014). Below, I outline each data source. I begin by describing the multimodal artifacts, then I move to the study's interview and observational data sources.

Multimodal Data Sources

The practice of preservice teachers creating visual representations of their educational experiences has been used before in teacher education research (Ellis, 2010; Bishop, 2009; Funkhouser & Mouza, 2013). Inspired by these examples and my work as an art educator, I designed three multimodal activities for the preservice teachers.

The first exercise was a Digital Diary activity to help the participants reflect on how they used technology both in and outside of school. When designing this activity, I was influenced by methodologies such as keeping logs (Davis, 2011) and making technology use maps (Taylor et al., 2018). I introduced the activity as an assignment in the Technology Seminar course. While all cohort members completed the assignment, I only analyzed the assignments of my six study participants. The assignment had three parts: first, the preservice teachers took notes about their technology uses for a week, with attention to what devices and digital applications they used and when, why, and where they used them; second, the preservice teachers analyzed their notes to answer the questions, 'How are your devices and digital media integrated into your life?' and 'How do they facilitate your daily activities and learning practices?'; and third, the preservice teachers engaged in an interest-driven arts-based activity in which they made a multimodal representation of their answers to the two questions above. I retained the assignments made by my study participants, and during our summer quarter interviews, I asked follow-up questions.

The second multimodal activity occurred during individual interviews as the participants were finishing their full-time student teaching in winter quarter. Over the prior quarters of the study, I compiled a list of the devices and applications each preservice teacher used during their

TEP, but the list format did not capture the complexity of how the preservice teachers used their digital technologies. Hoping to gain a deeper understanding of how they wove together their devices and applications, I brought each participant an 11x17 piece of paper and a set of cut-out paper ovals labeled with the names of their various devices and applications. During our interview, I asked the participants to review the ovals and place them on their big sheet of paper to illustrate *when* they used the technologies. After placing their ovals, the participants discussed their decision-making processes and provided examples of using various technologies. This activity provided authentic data about how the preservice teachers said they used technology within and across the three settings of their winter quarter experience. Lauren's sheet is shown in Figure 8 as an example. I discuss my analysis of this activity in Chapter Seven.

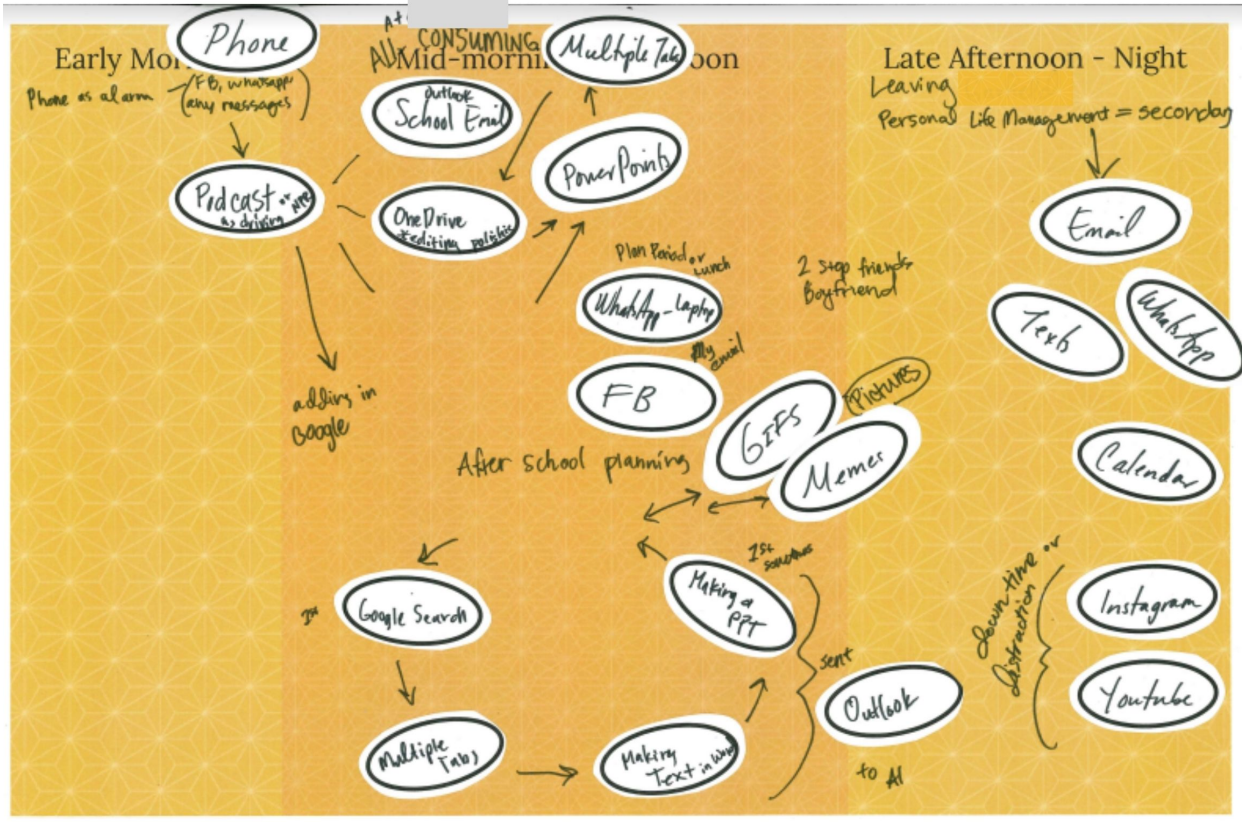


Figure 8. Lauren's cycle of technology use during full-time student teaching.

I call the last multimodal activity in this study Quarterly Digital Evidence, and it was inspired by my experiences interviewing preservice teachers during our pilot study. During some of these interviews, it seemed that the preservice teachers could not remember some of their own digital technology use behaviors, and I wondered if their practices were so thoroughly integrated into their daily lives that remembering the multitude of ways they used digital technology to support their learning was a challenge. Hoping to ameliorate this issue in my dissertation data collection procedures, I drew inspiration from visual and digital methodologies with studies utilizing a 'photovoice' technique, in which participants create reflexive images (Hurworth, 2003) to show the researcher how they understand their world (Lapenta, 2011) and to better highlight participants' points of view and document their experiences (Wang et al., 1997; Shankar, 2016). Based on this, I developed the Quarterly Digital Evidence activity, which called for participants to take a series of screenshots and digital photographs throughout each quarter, showing how they used their electronic devices and digital applications.

I asked the participants to take 10–20 screenshots or photographs showing how they used technology throughout each quarter. The participants took digital evidence to showcase their experiences (Clark-Ibáñez, 2004). A few days before each scheduled interview, I emailed the participant to request that they send their screenshots/photographs to me in whatever way was most convenient. Ever mindful of the participants' busy schedules, I wanted to make the process as quick as possible. The participants utilized different programs to send me their digital evidence (e.g., Lauren used WhatsApp, Lark used Google Photos, and Chloe emailed her examples). Once I received the participant's examples, I printed color copies for photograph-elicited questions in each interview (Collier, 1986). During each interview, I laid out the printed photographs on large tables and the participant went through each example and provided details

about why they used the tool. During their descriptions I would follow up with additional questions to learn more about the contextual factors in play.

Semi-structured Interview Data

I designed a series of semi-structured interviews for this dissertation to gain a deeper understanding of how the participants used technology in and across the different settings of their TEP. I utilized Patton's (2002) suggestion for creating interview questions based on source material such as the study's research questions, theoretical framework, and observations. In addition, I used the artifacts from the multimodal-based exercises to guide interview questions (Banks, 2011). The interviews therefore allowed me to collect data about the participants' experiences with technology in the multiple settings of their lives. I interviewed each participant after they completed a quarter of the study, thus four times during their TEP. Each interview lasted about an hour, with some going longer, depending on the number of artifacts shared by the participant. My interview questions are available in Appendix B. Overall, I collected roughly 30 hours of participant interview data for this dissertation.

In addition to interviewing the preservice teachers, I interviewed some of the participants' instructors and instructional coaches and talked informally with some of mentor teachers. These interviews provided contextual information about the preservice teachers' learning environments and a deeper understanding of how some teacher educators thought about technology and learning. A limitation of the study is that I did not conduct formal interviews with all of their university faculty and mentor teachers. This information would have provided more perspectives in terms of expectations, negotiations, and tool availability.

Observational Data

I triangulated my interview and artifact data with quarterly observations of the preservice teachers in their university or school classrooms. My observations ranged from an hour to two and a half hours long. During their spring quarter, I observed the participants in their university-based learning theory course. In the summer, I followed them into a local high school where I observed both their embedded methods courses and teaching high school students. In the fall, I observed university-based methods courses in social studies and science, and in the winter, I observed five of the six participants in their student teaching placements. One of the participants did not agree to my student teaching classroom observation request. During my visits, I took field notes about visible contextual factors that impact technology use, such as available technology, course activities, and peer relations. I also closely observed how the participants used their devices and applications throughout class periods and during peer-to-peer interactions.

Researcher Positionality

Qualitative researchers are the "primary instrument of data collection and analysis" (Merriam & Tisdell, 2014, p.16), and must be aware of their positionality and possible biases throughout the process of designing, implementing, and reporting on a study. In reflecting on my positionality, I must address my own role within the TEP and how it may have influenced my interpretation of the data. During the study, I was the instructor for the one-credit Technology Seminar course that met four times during the summer quarter. I clearly stated that preservice teachers' participation in my research was entirely voluntary and would in no way influence their seminar grades. I designed the seminar using a Connected Learning perspective in which teaching with technology can be used to create more equitable learning opportunities rooted in students' interests and digital practices (Ito et al., 2013, Garcia, 2014; Mirra, 2020). Therefore, I

presented a specific view of using technology in teaching and learning. To increase my own awareness of my influence as the participants' technology instructor, I engaged in a reflexive self-monitoring process throughout the data collection and analysis phases (Berger, 2015). During the interviews, for example, I focused on the participants' experiences, asking probing questions to better understand their thinking while trying not to compare their ideas to the concepts covered in our seminar class.

Data Analysis

I designed the data analysis to inform my understanding of how a cohort of preservice teachers used digital technologies over a one-year period. To best understand the participants' experiences, I analyzed the data both within each participant's experience and across the six participants (Merriam & Tisdell, 2016). These analyses allowed for in-depth study of the unique characteristics of participants' learning lives, while cross-case analyses provided opportunities to surface common themes (Borman, Clarke, Cotner, Lee, 2006). After each interview and observation, I wrote an analytic memo; these memos were descriptive as well as analytic to allow for both ongoing evaluation and identification of tentative themes (Miles & Huberman, 1994; Merriam & Tisdell, 2016).

Once I collected my data, I analyzed data collected from multiple sources to ensure that the study achieved internal validity (Denzin, 1978). I began my coding process by hand as I read through the interviews and observation data and looked closely at the artifacts. I utilized an open coding technique (Saldana, 2015) and culled codes from relevant literature. Throughout the entire analytical process, but especially in the beginning coding stage, I embraced my role as a creative researcher (Patton, 1990) by remaining open to the organic messiness of the coding process. For my first round of coding I used colorful pens to mark up the data and brainstorm

codes on large pieces of drawing paper (see Figure 9). Examples of codes identified during my first round of this process include *family influence*, *communicating with peers*, and *collecting resources*.

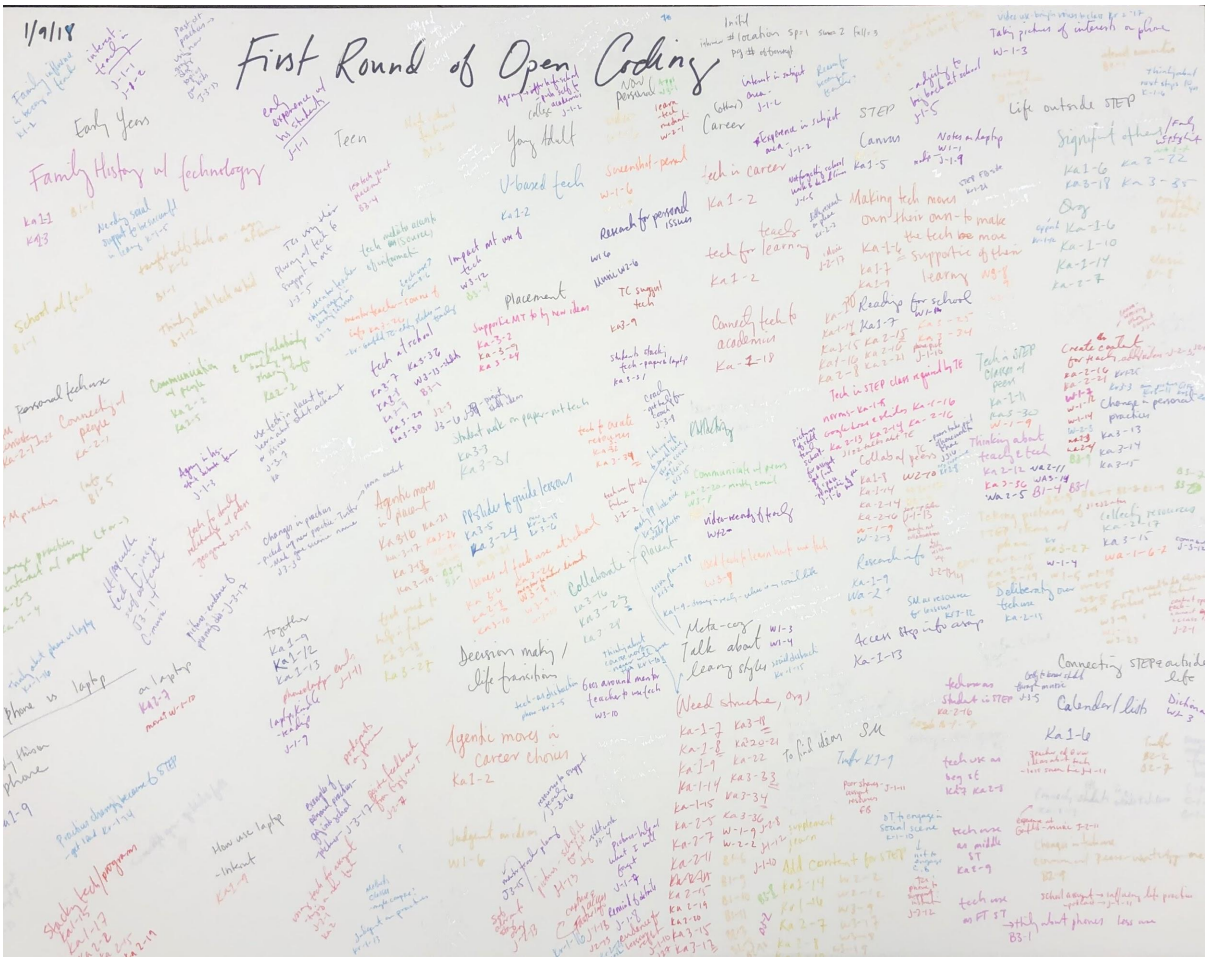


Figure 9. First round of coding.

In the second round of coding, I took an comprehensive approach to refining my codes by revisiting my list and looking for patterns and connections between codes (Saldana, 2016). Once I settled on a code list, I typed up the codes and cut them out to facilitate organizing them into broader categories (Merriam & Tisdell, 2016; see Figure 10). An example of a category is *content creation*, within which fell the codes *remixing*, *using technology to create own content*,

and *reusing existing content* (a complete list of categories and codes is provided in Appendix C). I then created Google Doc tables to help organize all categories and codes, and I added code descriptions to ensure consistency throughout my analysis process. I used the Atlas.ti program to help manage my large number of codes and data sources, and once all of my codes and data were uploaded into Altas.ti, I methodically went through each piece of data and highlighted it with the appropriate codes. During this intensive process, I employed a more focused coding approach, closely examining the data and writing integrative memos to bring themes from my analysis to the surface (Emerson et al., 2011).

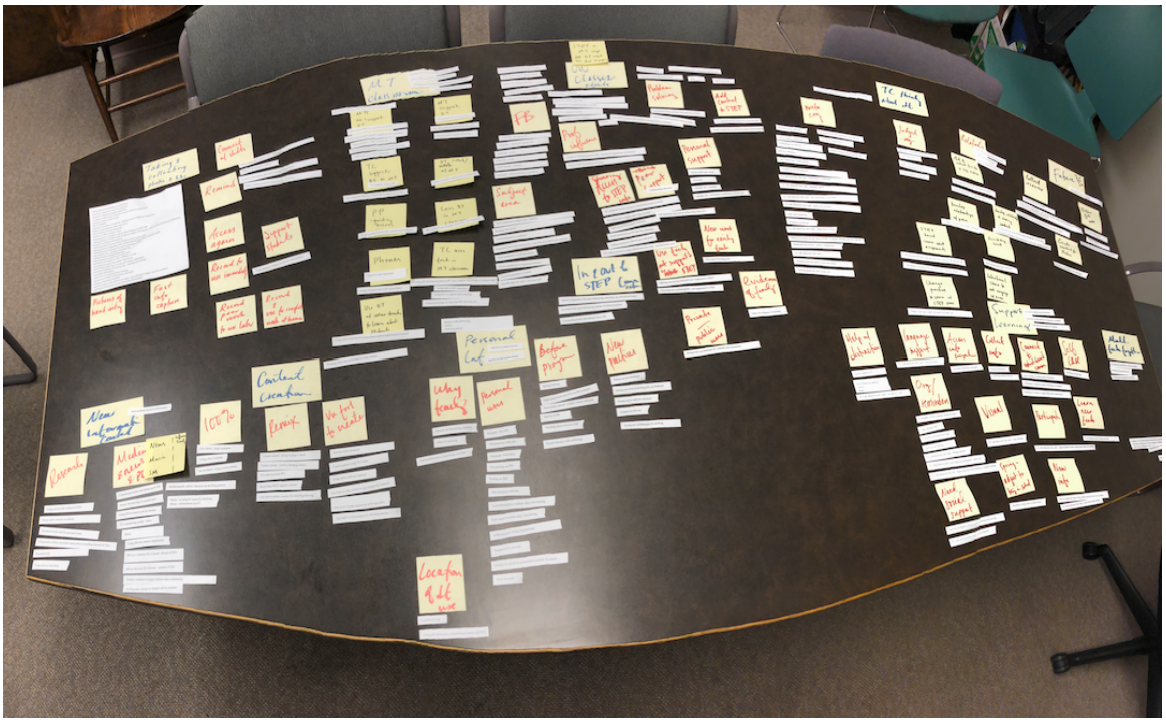


Figure 10. Developing my categories with corresponding codes.

I continued to engage in data analysis, spending considerable time making sense of the data as it pertained to my research questions. I followed Merriam & Tisdell's (2016) suggestion of rotating through the various components of my analysis process: research questions, code categories, quotations, and emerging themes. This exercise resulted in some preliminary findings

for each research question that I then organized in Google Doc tables and shared with my faculty advisor. In Part II of this dissertation, I present in three chapters the findings from my data analysis, showing how my diverse group of preservice teachers used technology to participate in the multiple settings of their TEP.

PART II

CHAPTER 6

The Composition of Preservice Teachers' Digital Lives

This chapter analyzes the digital lives of Chloe, Dylan, Lark, Lauren, Natalie, and Perl prior to their TEP. I approach this topic with a biographical perspective, focusing on the participants' personal experiences with technology to better understand the roots of their digital practices and attitudes towards technology. I explore three influential phases of the preservice teachers' lives: (1) adolescence, (2) emerging adulthood, and (3) the point of entering a TEP; and I provide evidence that other people can both shape preservice teachers' access to digital technologies and affect how they value and use their devices and media. The evidence presented in this chapter suggests that the preservice teachers in this sample have unique and meaningful prior histories with technology that create the foundations of their various utilizations of technology during their TEP.

Technology Use in Preservice Teachers' Families

Families can influence how children use technology and digital media in the home. A growing body of research shows the multiple ways that caregivers influence their children's use of media (Barron et al., 2009; Gee, Takeuchi & Wartella, 2018; Silvis, 2019). For many of my study's participants, family members, including both siblings and parents, influenced their access to and uses of technology in adolescence.

Natalie honed her technology skills at home by watching and trying to emulate her older sister's digital practices using programs such as AOL and Messenger. As Natalie grew up, she taught herself how to type and then later, how to edit photographs and videos. Now she also dabbles in Internet-based coding. Natalie's predilection for teaching herself how to use

technologies manifest later in these findings chapters through her own descriptions of techniques for arranging and evaluating digital platforms.

For many of the participants, parents especially influenced technology access, use, and values. Perl, for example, grew up in a family of computer science professors. Although she resisted following in her parents' footsteps at first, she completed an undergraduate degree in computer science and also pursued a graduate degree in the field. She noted in an interview, "I applied to a bunch of different grad schools for a PhD in computer science, figuring I'll go and follow the family trend and be a college professor." However, it is here that we see her break from her family's tradition: "I got my Master's, and spent five years doing operating systems research. I decided that I hate research." While she exited the university setting, she remained professionally active in the field as a software developer. Perl's family lineage in computer science was a significant factor that shaped her access to and use of technology. Unlike most of the other participants in the study, Perl approached her digital life from a software developer's position. She searched for technologies based on functionality and then tested their usability with precision. She also talked about using digital technologies to support her metacognition, and she called her electronic devices and programs her 'digital brain.'

While Perl's family helped shape her overall approach to thinking about and using technology, Dylan, an only child, provided an example of a parent influencing how they used technology to take notes. Dylan described how they took handwritten notes in school and then routinely transcribed them using a laptop at home:

> I've convinced myself that things will stick better if I write them out and then transcribe them, even though I don't know if that necessarily works. Sometimes I just do it so mindlessly that it's not an act of learning when I'm typing it up. I'm doing this because I told myself I had to do it and keep the routine...I learned it from my mother when she was in nursing school and I was in middle school.

While Dylan was thus influenced by their mother's practices, Lark attributed his use of photographs as a memory aid to his early excellence at visual-based picture games that he played with his father. Later, as a teenager, Lark learned to use video editing software to film and edit skiing videos with his friends, a skill that he later leveraged in editing videos of himself and his peers co-teaching. The two remaining preservice teachers, Chloe and Lauren, did not share specific family memories with technology. However, for the participants with family-based experiences, their families' influence on their access to and values surrounding use of technology seem to have influenced how these preservice teachers would later think about using technology in higher education settings.

High School Experiences

The preservice teachers in this study reported a variety of experiences using technology in high school. Four reported that *all* of their teachers used technology in the classroom, while two reported only a *few* teachers using technology. Examples of technologies used by the participants' teachers ranged from Smart Boards to digital quizzes and DVDs. Most of my study participants reported using little technology themselves in school-based settings. For example, Natalie used the Google search engine and the Google Docs program once a week in high school; Perl sometimes used a word processing program; and Lark used Wikipedia to jumpstart his project ideas. Dylan stands out from the group because they went to a high school described as "tech school," at which students were given individual laptops and teachers integrated technology into classroom culture. Dylan noted however that the "laptops [were] sometimes a distraction more than being helpful." And for Lark, one particular digital technology was an important element of social interactions in high school:

> I remember when I was in high school, you would ask somebody if you could look through their iPod playlist. And you'd get to know them better by what's on

> their iPod. So sometimes when I am teaching and there's some downtime, I'll ask kids, "You got any song recommendations for me?" Music is something a lot of people like to talk about, and teenagers in particular identify with music.

Overall, the participants had a variety of experiences using technology in high school with most digital tools replacing existing didactic methods of teaching and individual student work.

Next, I present a few salient examples of how my study participants' experiences as emerging adults (18–25 years old; Arnett, 2000), in university and workplaces, provided influential learning experiences for using technology.

Emerging Adults in University & Workplace Settings

All of the participants reported more weekly hours of electronic device use during higher education than in high school. On average, as college students, Chloe, Lark, Natalie, and Perl used computers or laptops for about 30 hours per week, while Dylan and Lauren used theirs fewer than 20 hours per week. All participants except Perl also used mobile phones at least 10 hours per week to assist them in completing their coursework. Five of the six participants described connections between their experiences using technology as emerging adults and how they subsequently used it in their TEP. During our interviews, the participants described using digital practices they'd developed as students or professionals in the workforce. Beginning with their time in higher education institutions, some preservice teachers learned specific technology practices by watching their peers. Lauren, for example, learned about reading and highlighting using an iPad by observing classmates. Lark, meanwhile, watched fellow students taking screenshots of their course schedules and setting the photographs as lock screens on their mobile phones for quicker access. Lark went on to adopt that practice, implementing it during his first quarter as a preservice teacher.

Whereas Lauren and Lark learned from their peers in university settings, Perl drew from a personal practice of using scheduling and time-tracking software to support her learning needs. She realized that she needed to add structure back into her flexible graduate student schedule:

> Grad school was very unstructured. I was very academically inclined and great with following [a schedule]. I found myself really lost when I didn't have the structure for it, so I was like, "I need to impose my own structure." It's been eight years of me doing this type of thing.

Observing Perl through the different quarters of her program, her time-tracking and scheduling practices supported her in managing the pressures and complexity of learning to teach.

Some preservice teachers also provided examples of learning to use specific technologies in workplace settings that transferred over to their TEP. For example, Lark learned how to collaborate with colleagues using Google Docs while working in a biology lab, and he built on this practice with his cohort of future teachers.

While the data collected for this study does not allow for a direct comparison of each preservice teachers' technology uses from adolescence through emerging adulthood, we do observe a common thread in the form of influential experiences driven by the uniqueness of preservice teachers' family practices, high school experiences, and skills gained in higher education or workplaces. What is notable here is the variation in the six participants' experiences with technology, as well as the personally relevant natures of their influences and preferred devices and applications.

Preservice Teachers' Technology Practices as They Entered Their TEP

To provide a fuller picture of the participants' lives with technology, I next analyze the participants' technology practices upon direct entry to the TEP. This data was collected during the preservice teachers' orientation week, using a survey with Likert and essay questions.

During the first week of their graduate program, I asked preservice teachers to self-report their current personal technology uses in and outside of school settings. My data analysis shows important similarities and differences between the preservice teachers' personal device use and digital practices. First, the preservice teachers primarily used two devices: their computers/laptops and mobile phones. See Figure 11 for a graph of weekly hourly use of each device as preservice teachers began their TEP. For computers/laptops, use ranged from around 20 hours to over 30 hours per week. There was a wider range in mobile phone use, Natalie used hers for ten hours per week and most of the other preservice teachers used their phones for 20 to 30 hours per week. Natalie explained her preference for using a laptop over a phone:

> I am half a generation behind with touchscreen phones ... It's not accessible to me. Sure, you could scroll up and down to choose the buttons, or the links that you want to go to, but I'd rather see everything as a full screen, and then be able to click it.

Conversely, Lauren preferred her phone over her laptop; but this choice came with negative feelings:

> I've started to use my phone more than my laptop for a lot of stuff. When I'm on my laptop, I feel like I have to work, but when I'm on my phone, it feels like it can be a fun thing. So I end up wasting a lot of time on my phone. It's actually terrible.

While the preservice teachers used both their computers/laptops and mobile phones in their TEP, this trend was not consistent with the other devices reported. For example, three preservice teachers watched their televisions, two preservice teachers used tablets and wearables, and one preservice teacher operated virtual reality technology. Thus, preservice teachers used a diverse range of devices as they entered their TEP.

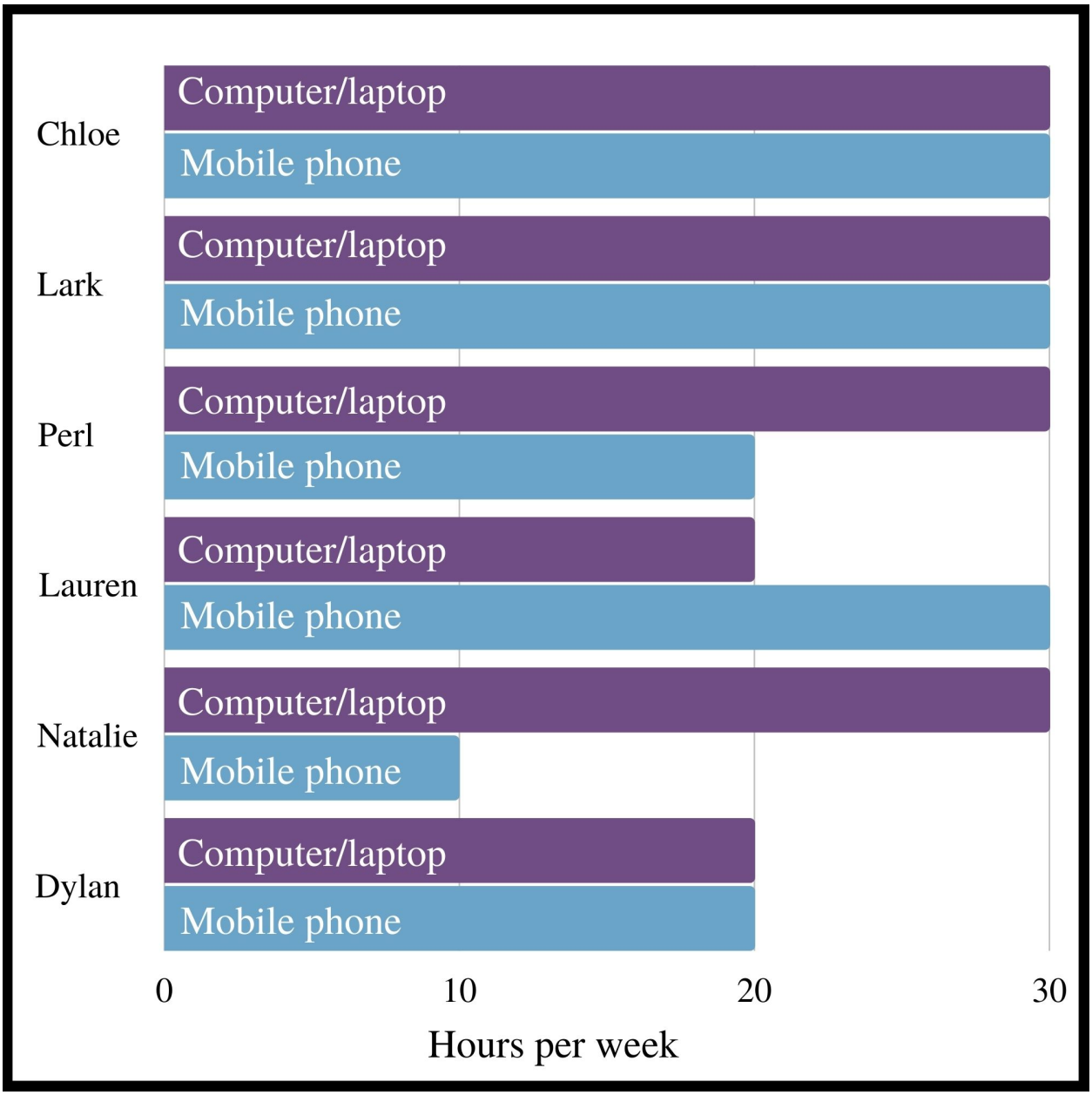


Figure 11. Total hours preservice teachers spent using computers/laptops and mobile phones.

Common Digitally-mediated Practices

Although preservice teachers spent varying amounts of time using their electronic devices, their self-reported numbers showed engagement in common digitally mediated practices. Entering their TEP, the participants used devices and digital media to facilitate much of their personal life management and entertainment. The most common activities were (in

alphabetical order) calendar/scheduling, cooking, emailing, listening to music, taking photographs, listening to podcasts, shopping, using social media, and texting. See Figure 12 for pie charts of the participants' self-reported estimates of weekly digital technology use, which ranged from around 10 hours per week to 30.

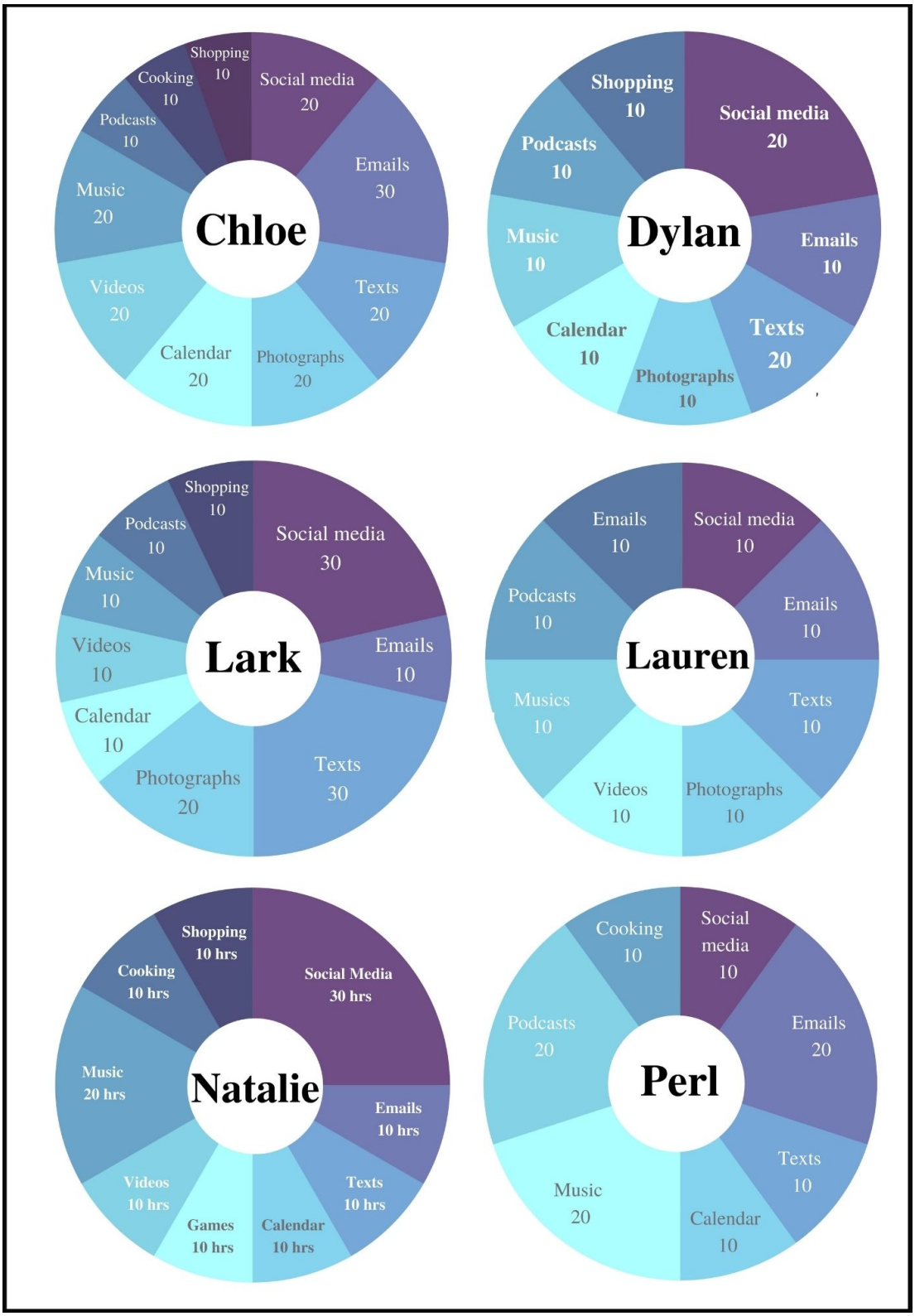


Figure 12. Estimated weekly hours spent by each participant on various technology activities.

Notably, the participants varied in how often they engaged in socially-based activities, the two most popular of which were using social media and texting. While all reported using social media to connect to large communities of people and communicate with family and friends, the preservice teachers used different texting applications for personal communications. For example, to stay connected to family and friends abroad, Chloe used WeChat, and Lauren and Perl used WhatsApp; Lark used Facebook specifically to check in with his father:

> The main social thing that I use [Facebook] for is with my dad, because my dad [uses it] big time-- he posts tons of news articles and whatever, like things that he's reading. So that's the only time I log in and I'm like, "Oh, I want to see what this person's up to… it's usually my dad, just because that's where he's posting a bunch of stuff."

My analysis also showed that these preservice teachers tend to choose specific digital applications that align with their intentions and goals. This rang true for Lark (as shown above), as well as for Natalie. She wished to keep abreast of Asian entertainment, for example, and she joined Twitter to connect with the most up-to-date information; however, she did not post her own content.

The Persistence of Prior Practices

As the preservice teachers entered their TEP, my data analysis suggests that they continued to use their digital practices formed years prior. Here are examples from Lark's and Perl's curated digital practices. Lark spent more time taking photographs than any of the other preservice teachers. He continued this trend of taking photographs in the different TEP settings to remind himself of academic topics covered, gain access to class content and group work, facilitate his participation in group discussions, document co-planning work with his mentor teacher, and to increase his students' learning.

One of Perl's top priorities was to establish structure in her daily schedule. One way that she accomplished this goal was to collect data to better understand how she spent her time. This helped her organize and control her workload. She reported using a Calendar application to organize her life for years, and this practice persisted during her TEP. Perl described her use of a Calendar program and Todoist (a web-based time tracking program): "Everything that I'm trying to keep track of [is in those programs]. It's my digital brain because you can schedule things … set up queues and things." Perl's data indicates that she developed her scheduling practice prior to her TEP and then leveraged it to manage her TEP's multiple classes, classroom locations, and assignments.

Compared to the other participants, Dylan reported using the lowest levels of technology, and this remained constant throughout the program. But the devices, applications, and practices Dylan did engage with were also rooted in routines they'd established years prior to the TEP. For example, Dylan consumed a daily diet of morning news, and they described how the television broadcast Democracy Now! and contemporary music informed and energized their teaching. In fact, Dylan said, "I've always been a news person. Ever since I was a kid, watching the news, reading Buzzfeed and other programs is a part of that." Not only did Dylan continue to consume the news during their TEP; they also continued their minimal level of phone and laptop use by intentionally keeping the devices in their book bag, in an effort to better concentrate in class.

In this chapter, I presented data about the study participants' early digital lives in hopes of creating a foundation upon which to better understand the uniqueness of their digital practices, the intentions behind their technology uses, and how their current practices emerged from prior experiences.

Discussion Section

The findings in this chapter address my first research question: what digital technologies did preservice teachers use before their TEP? This question provides a closer look into the compositions of the participants' digital lives, by examining their various preferences for electronic devices and digital media (e.g., Calendar and Facebook). I have taken a biographical approach in which I valued the participants' narrative-based recollections of prior experiences of learning to use technology and their choices about what devices and media to use in different settings (Burnett, 2009). In particular, this findings chapter contributes to what we know about preservice teachers' prior histories by positioning preservice teachers' digital practices as influential aspects of their prior histories and current beliefs—elements that can be used to support their individual development as future teachers.

The results from this chapter suggest that before the preservice teachers entered their TEP, they spent decades learning how to use different electronic devices and digital media, in various settings and with different influential people. The notion that preservice teachers develop unique histories with technology is supported by prior research that suggests that within cohorts, preservice teachers come with a diversity of experiences and ideas about technology (Buss & Fulton, 2012). Furthermore, the findings in this dissertation accord with previous studies showing that preservice teachers develop personalized ways of using technology, and they therefore should not be simplified into age-based or insider/outsider status-based groups (Burnett, 2011). Furthermore, my results are similar to those reported by previous researchers who have documented preservice teachers use of high levels of social media and their creating and sharing of digital content such as photographs (Lei, 2009; Kumar & Vigil, 2011). However, I argue that the findings presented in this chapter expand what we know about preservice teachers'

prior digital lives with evidence about how, when, and with whom they learn to use various digital tools.

The examples in this chapter also suggest that the participants' access, values, and technology-use practices can be shaped by influential people such as family members and friends. While the field of teacher education may not yet widely recognize the role of families in how preservice teachers' use technology, such practices are well documented in the fields of learning sciences and information studies (Barron, 2006; Davis, 2013; Gee et al. 2017; Pina et al., 2018). Although the self-reported data in my dissertation is not as in-depth as the ethnographic data in the studies listed above, my subjects' experiences do indicate a vital role being played by families and friends in access to devices and media, skills development, and perceptions of technology's value. This is important for teacher educators to consider: preservice teachers' uses of technology seem to have historical roots in their childhoods and teenage years. Thus, preservice teachers should be supported in surfacing these histories and thinking critically about how past experiences influence current and future uses of technology as teachers (Burnett, 2009; Matthew, 2017).

In order to account for the interconnected and dynamic nature of preservice teachers' digital lives, I suggest that we in the field of teacher education draw on research from learning scientists and media and information scholars to take a more ecological approach to studying preservice teachers. I am inspired by Ito et al.'s (2010) research and their concept of media ecologies; I draw on it in order to account for the interconnected quality—with a myriad of influential people, personal interests, community membership, and forms of media—of the preservice teachers' digital lives and practices. I believe that by adopting a media ecology approach, research can add more nuance to our understanding of preservice teachers' past uses of

technology, particularly by taking into consideration the impact of their families' values with regard to technology, device and media access, and personal interests.

In essence, my findings reveal how preservice teachers' digital practices and dispositions towards using technology are elements of their prior histories developed over time and can, in many cases, persist and change in novel learning settings such as TEPs. In the next chapter, I examine in more depth the devices and digital media that the preservice teachers used during the four quarters of their TEP at Cascade University.

CHAPTER 7

Preservice Teachers and Technology: Negotiations Between Internal and External Factors

I have organized this chapter into two sections based on the TEP's prominent location categories: the Cascade University campus and local middle and high schools. These locations are significant because they are rich with contextual factors such as material resources (artifacts, physical tools, and people) and conceptual resources (languages, ways of thinking, and participation norms) that affect preservice teacher participation (Lave & Wenger, 1991; Wertsch, del Rio & Alvarez, 1995; Fishman et al., 2014). First, I describe how the preservice teachers in my study used electronic devices and digital applications to participate in their Cascade University classes in terms of completing their assignments and interacting with cohort peers. From these findings, I conclude that although the preservice teachers may have had similar goals and tasks to complete, they chose and used different devices and programs to achieve these ends. The participants' choices for formal and informal digital practices seemed to stem from routines developed before their TEP. However, the preservice teachers' ranges of choices for available technologies were at times impacted by the norms set by their teacher educators.

In the second half of the chapter, I detail how preservice teachers used digital technologies to participate in student teaching placements in terms of co-planning, co-teaching, and digital media creation. These findings suggest that when the participants shifted to the role of student teachers, they used digital tools to accomplish more teacher-based work. Not only did the preservice teachers use specific devices, applications, and digital media to, in some cases, facilitate their work; they also created individually selected sequences of technologies that became familiar routines for their learning and teaching practices.

Cascade University Campus Courses

The preservice teachers began their TEP on the sprawling tree-lined campus in the Pacific Northwest. A majority of their coursework for the first quarter occurred in the almost one-hundred-year-old education building, with their subsequent quarters split between the campus and their field-based courses embedded in local middle and high schools. While on campus, the preservice teachers completed a range of courses covering topics such as adolescent development and racial caucusing, as well as subject-area classes (e.g., science methods course). During these courses, the preservice teachers used various digital technologies to facilitate their participation in individual assignments, class discussions, small group work, and peer interactions. The teacher educators in this setting ranged from tenured faculty to graduate student instructors and other educational stakeholders. The teacher educators designed their courses with differing levels of technology required in and outside of class.

Individual Responsibilities

The study participants presented themselves as future teachers with ideas for using technology to support their learning needs. Throughout our interviews, they seemed self-aware with regard their various uses of digital technologies to help meet graduate student expectations and requirements. I found that a majority of the preservice teachers used technology in these three categories: (1) accessing information, (2) organizing time and workspaces, or (3) creating helpful reminders. Below, I provide examples from each category, with corresponding remarks from some preservice teachers to elucidate their understandings of using digital tools to meet various learning needs.

Accessing information

A majority of the preservice teachers used their technologies to access information needed to complete course assignments. This entailed both searching for new information and accessing information provided by teacher educators. Examples included navigating course content (e.g., learning management systems), reading course literature (e.g., using digital reference management software), note-taking (e.g., handwritten or typed), online research (e.g., Internet searches for new information), and group collaboration (e.g., Google Docs).

Online Research and Digital Information Management. Chloe often employed Internet searches to complete her assignments: "We heavily relied on the Internet and technology for [our] projects. I am in a very new environment with new knowledge, [and I have] no idea." (See photograph #1 in Figure 13 for an example of Chloe's Internet searching for new information.)

When given information in class, such as readings, presentations, and resources for lesson planning and reflection, preservice teachers deliberately took steps to maintain personal access to the information. For example, preservice teachers regularly took screenshots and photographs of online and whiteboard classwork, digitally color-coded their readings and notes, and transferred documents to the Cloud. Lauren described her routine of taking screenshots to have access to information: "It's a safety backup. If I lose my papers and don't have the Internet, I will still have screenshots of my information. I do it all the time for security. In case something goes wrong, I'll have all the information." She engaged in this practice both at school and in her personal life. At school, she took screenshots of Canvas after submitting an assignment as proof of her work (see photograph #2 in Figure 13 for an example of Lauren's practice). She also wrote information on her hand and then photographed it. She said, "I'll take a picture of my hand so

that if it erases, I'll still have a picture of it. So I didn't have to take notes; it was a screenshot or a picture."

Lark also wrestled with wanting instant digital access to course information in a class where the professor provided paper copies (see photograph #3 in Figure 13 for an example of Lark's use of Canvas to find digital versions of coursework). He commented:

> One time I lost the hard copy and I had to frantically email everybody. If it was on Canvas I could look it up ... some people like to have hard copies of everything, and they organize it in a binder. That's not me. I like being able to know where I can access the information and just keep it. I won't ever have the problem where I went to the coffee shop to do homework and I realize I forgot my binder. Or I'm on campus, I don't have my computer, it's all saved as a hard copy on my computer. I love when it's on the Cloud. So that's why I like Evernote, Mendeley, and Canvas. You can log on to it from any device. It's Cloud-based so you can get it wherever.

The examples above show that many of the preservice teachers in my study took steps to create and maintain digital access to information to enable completion of assignments on their own time.

Note-taking. The preservice teachers described their methods of taking notes using different digital programs and handwritten approaches. While most took notes during class, they differed in how they thought about their notes, the programs they used, and their note-taking practices. They were fairly split, either taking handwritten notes or typing them on a word-processing program. Their preferences informed their choices for processing and recording information. However, choices about how to take notes sometimes proved complicated. Perl, for example, wrestled with her desire to cognitively process the notes by writing them by hand while also desiring the searchability of typed notes. She remarked:

> I feel like my whole quarter has been a debate between like, "Do I go analog or do I go digital?" I'm not entirely sure where I'm going to land on that. I'm leaning a little more digital at the moment, but I process things better in handwriting.

As her TEP progressed, she tried out other methods, such as taking notes with digital notebooks and photographing her handwritten notes to store on her laptop. But while Perl grappled with these analog and digital choices, Lauren was committed to her practice of taking handwritten notes, observing, "I don't like typing notes. I'm not going to want to return to typed notes." In contrast to these preservice teachers, Chloe and Natalie typed their notes during class. Natalie leveraged the affordances of typeface choice and colorful fonts to maximize her note-taking abilities:

> This is my process for starting a class period's [notes]. I always write the date, and then anything that's homework or important notices are always color-coded. Then after that, I start my notes. I thought orange was alarming, but it wasn't too scary of a color. That's what I use. I use red for deadlines, really alarming deadlines. I do use Calibri [typeface]. I use Calibri for all of my notes and even assignments before teachers tell me, "You have to use Times New Roman."

These examples of preservice teachers' note-taking practices suggest that they identify the need to complete a specific task, but accomplish it using different means. Moreover, when the preservice teachers in my study had the opportunity to choose their process and digital tools, I suggest they made decisions that were calculated based on their technical fluency.

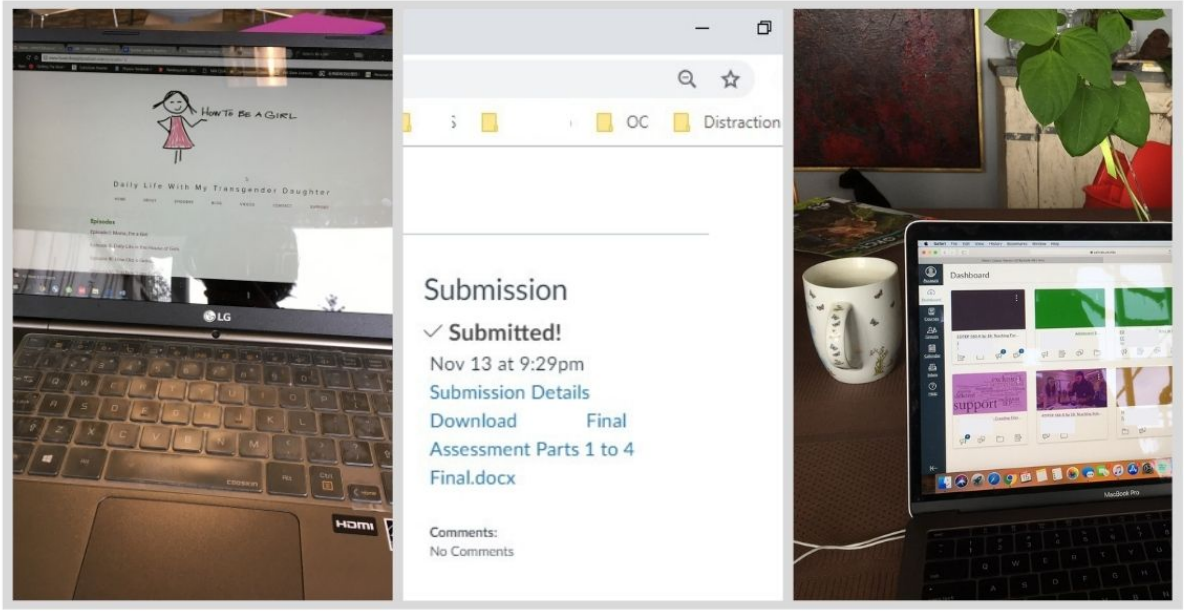


Figure 13. Three examples of preservice teachers using digital technology to access information.

Organizing Their Time and Workspaces

Undoubtedly, the year-long TEP was an intense experience and required the preservice teachers to develop a system for organizing all of their responsibilities. While most preservice teachers used a calendar program, Perl led the way with her layers of digital organizational programs such as Todoist along with multiple Google Calendars (see photograph #1 in Figure 14 for an example of Perl tracking her time). Perl leveraged prior practices using time-tracking and scheduling programs to build structure into her TEP's flexible schedule, but with a particular focus on gathering information about how long she needed to complete her tasks:

> I consider [the programs] an aid for metacognition. I'm really bad at estimating tasks. I think most people are, but having data to back it up helps. This is part of my workflow now. What I like about it is at the end of the week I can go through and look at where I spent time. I can know that a certain week was really heavy with one particular thing or it's like I felt I worked a lot more and I can go back

> and be like, “Oh yeah, I worked a 60-hour week on schoolwork. That’s why it feels like I’m so much more exhausted.”

With the preservice teachers having little control over their schedules, it may be the case that Perl used her multiple organizational programs to maintain some control. And I describe later in this chapter, the preservice teachers, in general, desired more autonomy in their learning.

Preservice teachers also managed their time by limiting digital distractions to help them focus on their work. For example, Dylan continually spent time organizing the multiple desktops on their laptop to declutter their digital workspace. On each desktop, Dylan opened different applications that they would use throughout the day, thus multitasking while using their laptop. (See photograph #2 in Figure 14 for an example of Dylan’s desktop organization.) Lark asserted that he was not a multitasker and had few applications open on his laptop when he was working. He described his working style thus: “I try to keep it separate as much as possible. I’m a procrastinator. Usually, when I’m doing homework, I have to get it done. In general, I do best focusing on one task at a time. Not multitasking.” Natalie also knew what she could handle while working on her devices and intentionally chose to have few applications open. “That’s also my way of not getting too overwhelmed, especially when teaching is multitasking in its essence.” (See photograph #3 in Figure 14 for an example of Natalie’s web browser tabs.) Taken together, this evidence suggests that the preservice teachers developed personalized approaches to creating effective digital work environments for successfully completing individual assignments.

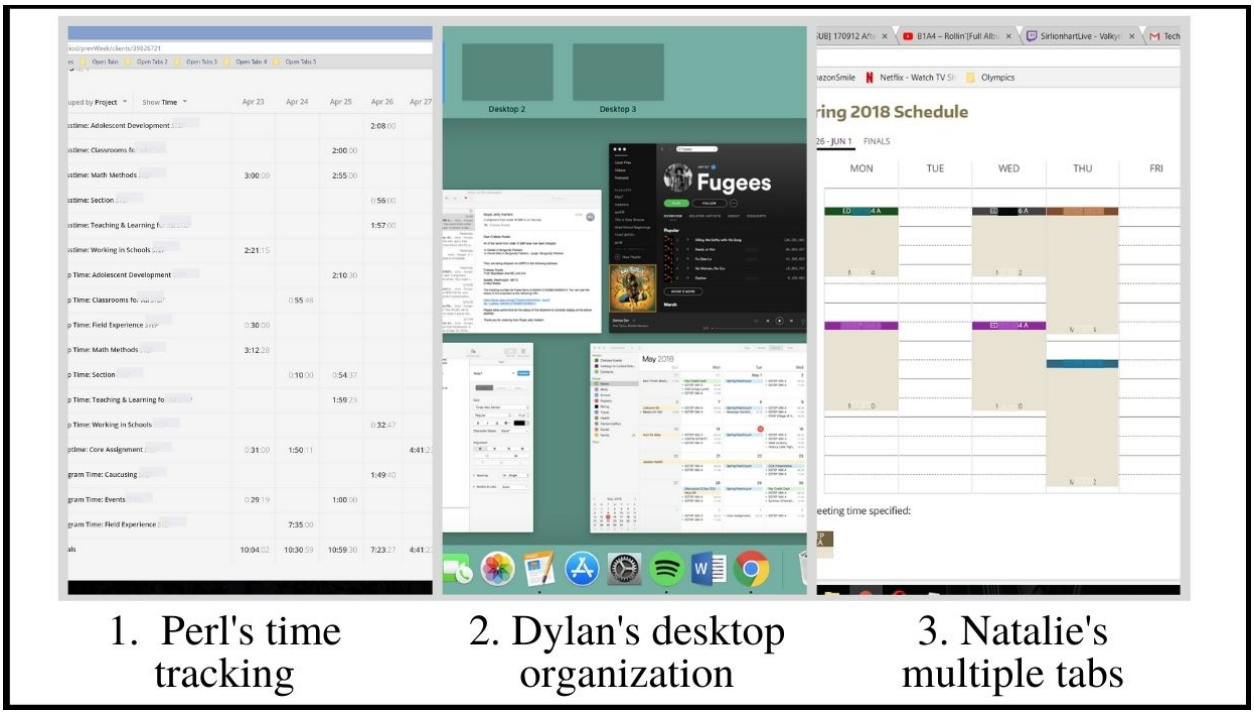


Figure 14. Three examples of preservice teachers organizing their workspaces.

Creating Helpful Reminders and Motivators. In addition to the preservice teachers organizing their schedules and work environments, many of them also took steps to use technology to remind themselves of specific information and due dates. Natalie provided a notable example with use of the Google Calendar program to remind herself of relevant information that she wanted to discuss during her classes. Natalie created daily calendar events on her Google Calendar, noting, "on the day, mornings usually, [my personal Google Calendar] will send me an email, saying 'hey, talk about this.' Then it's on my home screen to read the message about this event, [and] it's really just a reminder to talk about it." In this particular case, Natalie recognized her personal need for daily reminders and leveraged her understanding of the Google program's daily nudges to increase her ability to participate in class discussions.

The preservice teachers also used their mobile phones to set up digital reminders. The two most common types of reminders were photographs to prompt their memories and a note-taking

application to type up lists. Most used their mobile phones to take photographs or screenshots of relevant information to access at a later date. For example, Chloe took pictures during a field trip to a local museum to use later in an assignment and Lark took photographs not just to remind himself of the experience but to share it with his family and friends on Instagram, "my friends that don't know anything about teaching and they can see what I'm doing in my job, or in my grad program." Lauren captured screenshots with her mobile phone to create reminders of digital content she wanted to have access to in the future. In addition to the photographs and screenshots, some preservice teachers used the notes application on their phones to create running lists of relevant information to reference in the future.

Class Participation

In the previous examples, the preservice teachers were provided with few parameters impacting their choices regarding which digital tools they used to support their learning needs. However, during their class periods, teacher educators (i.e., professors and instructors) provided more direction about using technology to participate in shared activities.

Group Discussions. There was no consensus among the preservice teachers about how to best use technology to participate in small group discussions. Three of the preservice teachers reported using their mobile phones to positively impact their participation in group discussions in two main ways. First, they took pictures of the discussion questions presented by their teacher educator on the projection screen to have a personal copy available on their phones during the discussion period. For example, Lark described an instance when the teacher educator was flipping back and forth between slides and asked the preservice teachers to write down the questions on the slides; in response, Lark said, "I can just take a picture and just set it on my leg here and then while we're sitting at these chairs, I just have it right here." Perl engaged in a

similar practice of taking pictures of discussion questions (see photograph #1 in Figure 15 for an example of the discussion questions). The other major use of mobile phones in group meetings was for participant time management: Chloe described being a group leader and using her phone's stopwatch feature to uphold the group's desire for equitable talking time for each member.

Conversely, two preservice teachers consciously left their phones in their bags in order to focus on interactions with their peers. Dylan noted, "I'm trying to keep distance with my phone. I see technology as a distraction. I am trying to maintain being present with my cohort and my teachers." The variety in the preservice teachers' approaches to using and not using technology to engage in class may be linked to differences in personal ideas about what attentive participation in class spaces entails.

Small Group Work. Throughout the TEP, the preservice teachers engaged in various small group work facilitated by digital technology. Teacher educators played a prominent role in setting up these collective experiences mediated by synchronous applications such as Google Docs. These distributed learning opportunities included collecting shared resource lists in the English Language Learning and Educational Technology courses, creating shared annotated bibliographies in Adolescent Development, and small group assignments to research and co-planning units in the Tribal Sovereignty class (see photograph #2 in Figure 15 for an example of a class's Google Doc).

The preservice teachers in this sample navigated these opportunities to engage in synchronous and asynchronous activities with other peers. Chloe described one such example: "We use Google docs very often because we have a lot of group work. For example, we were making a presentation, and we needed slides. We have to work together, so we need to use

Google slides so everyone can contribute." Thus, both the teacher educators and preservice teachers used synchronous-based programs to collaborate both during and outside of class time. This practice also applied to some of the participants' co-planning experiences.

Co-planning with technology. The preservice teachers described opportunities to co-plan with their peers during the summer quarter working with rising ninth grade students in a local summer school. Teacher educators set up shared Google Folders, Docs, and Slides to facilitate the preservice teachers' co-planning and co-teaching summer quarter experience (see photograph #3 in Figure 15 for an example of a shared Google Folder from the summer). One teacher educator drew on her values surrounding technology use when selecting the Google programs:

> Just to be transparent...I really love technology and I have the most control using Google Tools. I can control how things looked and they very much reflected my own style. I would create a daily agenda for the [preservice teachers] and I did go over it, and that was shared with them. There were links that led to Google Drive files that we all shared and collaborated in, including a schedule where they could sign up [for teaching days]. Then they would brainstorm and people could make comments or I could leave comments. And so in the planning structure, that was really useful.

This university-based teacher educator utilized the synchronous nature of the Google Suite to organize, communicate, and provide feedback for the preservice teachers throughout their summer high school placement.

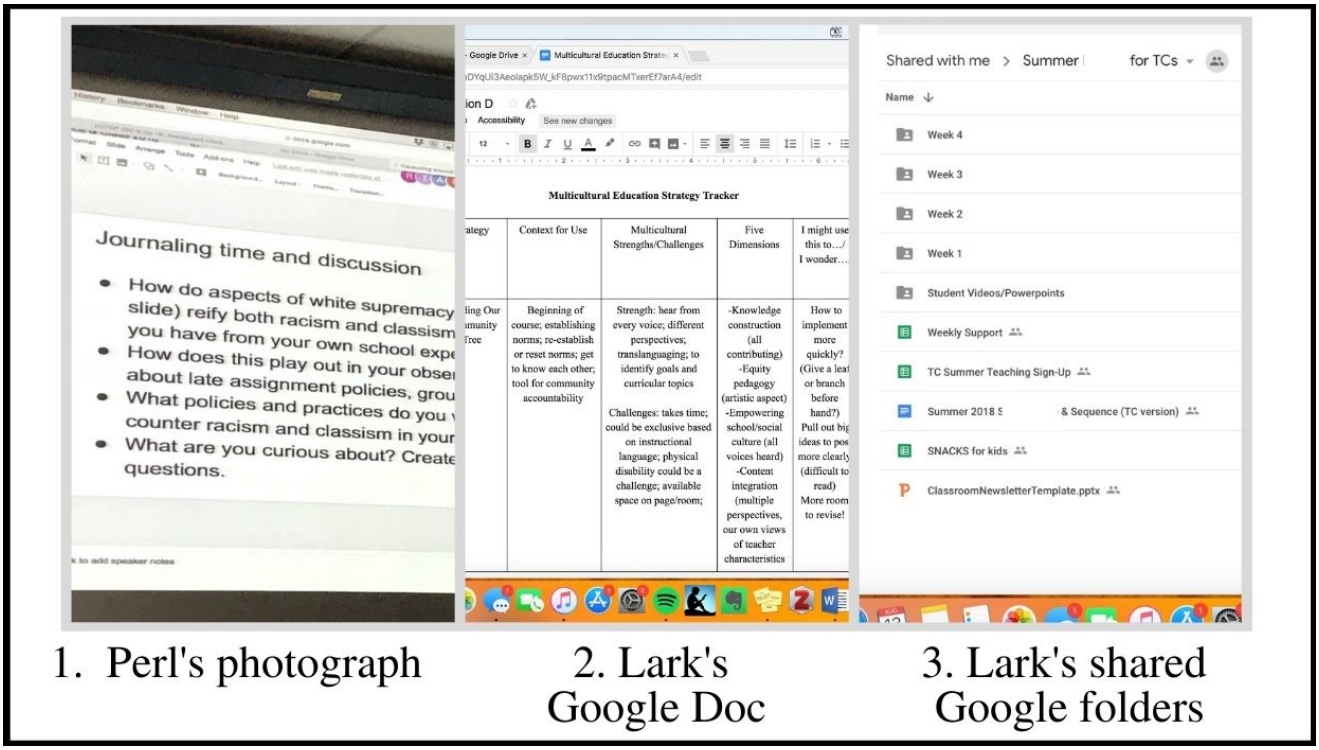


Figure 15. Examples of preservice teachers using digital technology to participate in group work.

Peer Communication and Relationships

As briefly introduced above, the preservice teachers worked together in and after classes to complete their coursework. Therefore, in some cases, the preservice teachers sought to develop personal relationships with their peers. Lauren was particularly invested in wanting to establish a community for moral and programmatic support. To achieve this aim, she launched a Facebook group, even against the wishes of the administration, who warned again the practice based on issues with prior cohorts using Facebook. Lauren had a specific goal in mind:

> I want this as a resource for "hey, I read about this cool article or I'm going to drink here tonight. Come and join me." Because I'm also new and I didn't know what kind of annotation thing to use. I don't know where I should print stuff in school. So that's why I wanted [the Facebook group].

In the early days of the Facebook group, Lark described it as mainly for academic purposes focusing on sharing resources for their independent study course. As their program progressed, the Facebook group gained members and diversified to include more social communication. In describing this progression, Lauren said, “This is what I wanted, I wanted [the Facebook group] to have its life of its own, and other people to be doing it. So that’s been cool.”

Others’ participation in the cohort’s Facebook group varied. Natalie joined the group, but she did not often use it. Perl would check it for updates when she remembered to do so, but participating in the online space was not part of her daily routine like (as it was for Lauren). Lark and Chloe checked the group page more often. In the winter quarter, Chloe remarked,

> I get a lot of information about [my cohort], their lives, and how they are doing. Also, I [learn] about their student teaching experience and job information. We share information within this group if we have anything we know. I will respond sometimes and let them know what’s going on. For example, a colleague of mine didn’t know we had a career fair yesterday. I posted “I’m going to that one”, then he texted me, “Which one were you talking about?” I was like, “You didn’t get the email?”

Chloe’s example indicates that she used the Facebook page as part of a more extensive digital communication system that included texting and emails. For the preservice teachers who used the group, it became a space to connect with, learn from, and contribute to a running discussion about the TEP and their lives.

Yet, the Facebook group was not perceived as a welcoming space for all of the cohort members. Dylan had no interest in socializing with their peers online. Dylan’s desire to separate from the cohort developed during the beginning of the program, as they felt tension with peers during class interactions centered around social justice issues and personal identity work:

> I feel like it’s just that basic shit. It’s fucking white cis men, fucking white straight women. It's that kind of shit. I understand it's my work to work with them and bring us up, but it’s also exhausting because [I], as a gender queer trans-masculine lesbian, have done a lot more thinking about these things.

When asked about joining the cohort Facebook group, Dylan commented:

> I did not join out of stubbornness and…apprehension of integrating myself into this mass...I'm not about to join some fucking, like, mainly straight [Facebook] group in which they're always inviting each other to parties where they drink. So I have no use for that type of Facebook group.

While Dylan did not join the TEP's Facebook group, they used Facebook in their personal lives with friends. Dylan's lack of affiliation with the TEP's Facebook group may indicate that Dylan was not interested in participating in an unregulated digital space with their peers. Instead, Dylan developed a close friendship with another queer student in the program, and they texted and talked on the phone daily.

Apart from the Facebook group, some preservice teachers used different text messaging and email services to communicate with their peers. Interestingly, during the summer quarter, the preservice teachers in this sample used various programs that seemed to be drawn along the lines of subject area boundaries. The STEM preservice teachers tended to use email or Canvas to communicate, while the humanities preservice teachers used WhatsApp texts. I ascribe this difference in modalities to the preservice teachers' personal preferences. In STEM, we had Perl, who preferred email, and in the Humanities, Lauren, who preferred WhatsApp:

> I always prefer to use WhatsApp, which I know is my thing. Yeah, that's how I would reach out to them first, but sometimes I know that people don't check WhatsApp, so then I text them if I really need to get ahold of them, but to the group, I'll do it on WhatsApp first.

These informal modes of communication seemed significant to how the preservice teachers were learning through interactions. For example, during the summer co-teaching experience, two of the social studies preservice teachers reported use of texting services to plan lessons with their small groups. The preservice teachers thus communicated both in and outside of class to develop the resources needed for their teaching periods, a finding that raises important questions: How do

these informal modes of communication impact peer collaboration? And what does that mean for preservice teachers who do not partake in those specific services?

Student Teaching Placements

The second half of the TEP primarily focused on the preservice teachers' student teaching placements and their trajectories from co-student teachers to lead-student teachers. This change, which began in the fall quarter, introduced each preservice teacher to a new location with different mentor teachers, subject-area teaching teams, administrations, students, classrooms, and school cultures. In conjunction with their entry into novel environments, the participants inhabited new roles that required increased responsibilities, tasks, and goals. The preservice teachers' responsibilities shifted from individually processing new content presented in their university-based courses and co-planning with peers to working closely with their mentors to plan, teach, and assess multiple classes of students. Along with these shifts in responsibilities, we see a change in the preservice teachers' engagement with technology, with more time spent on work as future teachers and less time on personal and entertainment-based digital practices.

Working with Mentor Teachers

The mentors' co-planning styles and their methods for providing feedback guided the technologies the preservice teachers used to participate in these mentor-mentee relationship. The preservice teachers' reports showed that they utilized a variety of different technologies to facilitate lesson planning and implementation and to receive feedback from their mentor teachers.

Those preservice teachers not connected to teaching teams (Natalie, Lark, and Chloe) were expected to use technologies chosen by their mentors. For example, Natalie would work

side by side with her mentor in the classroom to co-plan, she on the classroom's desktop computer and her mentor on his laptop. In contrast, Lark primarily planned with his mentor teacher on a large whiteboard. After such a session, Lark would take a photograph of their co-planning work to support his lesson planning at home (see photograph #1 in Figure 16 for an example of Lark's whiteboard work).

While Natalie and Lark had amiable relationships with their mentors, Chloe had a different experience: she began her student teaching placement by asking for feedback from her mentor, but after only receiving negative responses, Chloe stopped asking for his comments:

> It felt like he was always trying to convince me that my thoughts and strategies are not very thoughtful. After a couple of times, I decided not to ask permission; I don't need that because I'm not doing any damage or harm to the students. I'm trying to do the teaching that I think is right that's good for the students. I also have research-based [ideas] from my program, Ambitious Science Teaching. It's the way I teach. This is my opportunity to actually do what I learned, so I don't want to miss this chance.

Chloe's determination to teach in accordance with her beliefs is a running theme in her data. In the next section and subsequent chapters, we see her displaying confidence in her ideas as a teacher and in her capacity to learn new technology tools for teaching.

Working with Subject-area Teams

The preservice teachers who worked with mentors who were members of a subject-area teaching team were expected to use the technologies chosen by the larger group. This included both digital applications for sharing curricula and day-to-day communication services. For example, Perl and Lauren worked closely with other teachers to use Microsoft's cloud-based file hosting service called OneDrive. These two preservice teachers used this tool to facilitate lesson plan sharing with teachers on their team, and throughout this collaborative process, both preservice teachers had access to all of the department's teaching content. Perl and Lauren took

advantage of this to download the collection of curricula materials before they graduated (see photograph #2 in Figure 16 for an example of Lauren's OneDrive).

In addition to file sharing, Perl and Lauren described other issues surrounding technology use when working with their team. For example, Perl felt like her team's process for creating and sharing their summative assessments was not technically sound. She described the pushback she received when trying to ameliorate an unsustainable mathematics test key system (i.e., the correct answers to the test questions) that the team had in place:

> We have a lot of test keys, and I would create a key and there's always someone else teaching the lesson, so I can do it by hand, scan it, and then email it. Or, I can just write the test key in Word. But I found that the teachers were not comfortable with using Word for the answers. It would sometimes work if I exported the Word key to PDF. We have a phone text chain so we could just take a picture of the test key and text it. It just feels really unwieldy to be doing it that way. I mean, yes, I guess I'm a little bit faster doing math by hand on paper than I am on my tablet, but if they're going to use the same test key year after year, we should have it in our OneDrive.

Perl's example shows the complexity of working within a team of teachers with a prior history of using digital tools in specific ways. Perl reflected on her mathematics teaching team's texting practice in general and suggested that, despite the complexity, it affected her relationships with teachers in a positive way: "it's a more intimate relationship over text than it is over email. That's just the mode that you're in. So I feel like I got to know the other Geometry teacher, much better for being on that text thread." Here, Perl reinforced the social aspect of teaching and working in a department (see photograph #3 in Figure 16 for an example of Perl's text chain and test key).

Lauren negotiated her participation with her social studies teaching group at a different school in both face-to-face and digital communication. As a new member of the group, she primarily read the emails and did not contribute to the chains. "The 9th grade team has a group

email. It is 90% about the curriculum, 5% questions that need to be answered at a group sourcing level, and the remaining 5% is like joking around stuff." In addition to their email communications, the teachers met as a group to present the unit and lesson plans they created for the teaching team. Lauren described her apprehension about presenting at an upcoming meeting:

> It's intimidating. Tomorrow we'll present to the 9th grade team and say, "Here's what we're doing. Here's some information." Then they'll tell us that looks like trash or something. Actually, these sessions get so intense. There's some weird stuff that goes down in them sometimes where I'm like, eww…you guys are really catty. It's very passive aggressive. I'm just like, this is horrible.

Above, Lauren highlights one example of the reality of preservice teachers working with mentor teachers and teaching teams in digital and in-person settings.

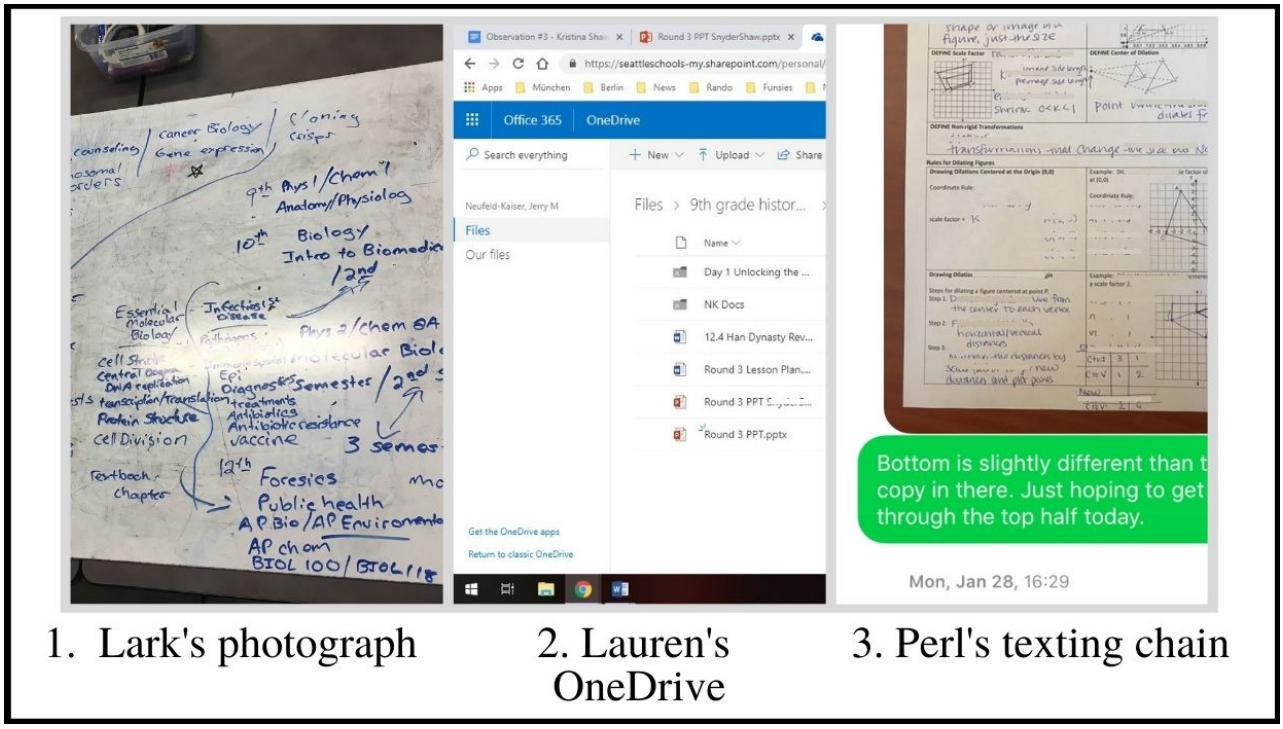


Figure 16. Examples of preservice teachers using technology to facilitate work with mentors.

While analyzing the preservice teachers' interviews, I discovered that their relationships with their mentors ebbed and flowed in different configurations as they encountered miscommunications, received positive feedback, needed support, and had divergent ideas. Communications moved across different modalities as they used technologies in conjunction with face-to-face interactions and discussions. Therefore, it is important to think about preservice teachers' technology uses as part of a larger ecology of participation that includes multiple modes of communication.

Preservice Teachers as Content Creators

While in their student teaching quarters, the preservice teachers used electronic devices and digital applications to create digital content in service of their lesson plans. A majority of the preservice teachers created graphics, worksheets, quizzes, and presentations consisting of media that they found, modified, or created using digital programs. However, the degree to which the preservice teachers could create media for teaching depended, at times, on mentors' parameters for their lesson content, instructional activities, and implementation. For example, Perl, Lauren, and Dylan taught in classes where departmental teaching teams suggested much of the content and instructional strategies. Lauren was frustrated with her situation:

> I was reined in because of group planning, I did not get to just do the wild fun thing that I wanted to try. Even when I was planning my lessons . . . I was so obsessed with doing what I thought everyone in the department would do, so I did not do what I wanted to do.

Lauren's description of her experience seemed a little tighter than the accounts from Dylan and Perl. Those two preservice teachers had a little more wiggle room for diverging from the group's lessons, but all three preservice teachers were constrained by mentor teachers' parameters, which included using reusing preexisting curriculum, presentations, and lesson resources. Perl, Lauren, and Dylan, however, each occasionally made small moves to add content to their lessons. Natalie

was able to choose the material covered in her classes, but her mentor recommended that she use his style of presentation to create lesson continuity after she graduated. “I was told I could do whatever I wanted [for the lesson content]. And I really did appreciate that freedom. I did have pressure to maintain what has been done in terms of pedagogy and lesson formats.” In the science student teaching classrooms, Lark and Chloe were given more freedom to design and teach their lessons because their courses were outside the schools’ traditional science class offerings.

The Impact of Subject Area Knowledge

The preservice teachers’ levels of subject-area content knowledge also influenced if and how they created digital or paper materials. For example, Dylan and Lauren were less familiar with the historical time periods and regions they taught in their social studies courses. Being unfamiliar with the content meant the preservice teachers had to first increase their knowledge about the topics before creating their lessons. Dylan spoke passionately about their interest in and dedication to being an anti-racist teacher and their desire to use Democracy Now! news videos in their lessons. But, alas, Dylan said, they felt a disconnect between their current events knowledge and lessons plans they were asked to teach. These lessons were rooted in more historical time periods: “Unfortunately, in ancient US history, or ancient world history, [contemporary] US history doesn’t come up a lot in class.” Therefore, Dylan did not use their established digital practice of news consumption each morning to support their lesson planning process. Instead, Dylan used the required curriculum and textbook. However, lack of familiarity with class content was not always the sole factor in the preservice teachers having less say in lesson creation. In Lark’s case, he was new to some of the science material (e.g., diabetes), but his mentor teacher was flexible and encouraged Lark to implement his own ideas in creating

lesson resources. Thus, it seems that when using digital tools to create resources for their lessons, preservice teachers grappled with multiple factors, such as mentors' parameters for lessons, their levels of expertise in the content, and available technologies.

Using Media Created by Others

The preservice teachers often used digital technologies to find and integrate media created by others, without altering it. Examples include YouTube videos, photographs, or graphics found on the Internet. In most such instances, the preservice teachers used digital media to increase information relevancy for students. Chloe used YouTube videos to illustrate the science phenomena her students were studying and to relate them to human experiences. Lauren used photographs and GIFs to increase student interest in social studies concepts. She recounted an example when she had to use a presentation created by another teacher: "I added photos because I thought it would be relatable [to students], and it is related to what we studied." Lauren went on to explain her additions of GIFs to the presentation:

> It's not [the teacher's] fault; it's just the way she does things. She puts a lot of text on slides, and I am always like, this is way too much. I'm going in and erasing a lot. Also, because teachers never use photos, it's just slides of text. I was like, this is not relatable at all, so I put this GIF on there.

Lauren's is one example of a preservice teacher who exercised her agency during her student teaching experience to impact student learning. She acted on her instincts that the design of the presentation did not meet the learning needs of her students and changed the slides by adding pre-made media. Natalie engaged in a similar practice with her presentations when she thought about addressing her students' emotions while at school:

> I tried to make the opening [slide] a lot more friendly. I put cute designs and show emojis and stuff like that. My mentor teacher really liked to use Times New Roman [font] a lot. And it's a serious format. I think for the students who are also really anxious knowing that they're getting behind on their research projects and stuff, those were my visual cues to be a bit more inclusive.

These three cases show examples of preservice teachers using the Internet to find pre-made digital content, such as videos, photographs, and fonts, to adapt their mentor teachers' lessons to align with their own ideas about how students learn.

When it came to sharing student work, Lauren adopted a practice from her mentor teacher. "I'm sourcing a lot of my own photos now. My teacher does it too. He'll take pictures of student work sometimes and put it on the PowerPoint. So I am taking my own photos, using my phone's camera to create them." Lauren's example shows how she incorporated a digital practice from her mentor into her actions as a lead teacher. In addition, Lark and Lauren both took photographs to illustrate specific scientific processes. Lark engaged in this practice both in his summer co-peer teaching experience and during his student teaching quarters. In particular, he took multiple photographs and time-lapse videos to embed in his presentations to illustrate the steps of the students' experiments.

> One of the coolest things was that I recorded a time lapse video... There was one part of the lab where you can see the glowing proteins slowly moving through this bead matrix. But it takes like 15 minutes in person. So you don't really get to see it unless you do a time lapse, and so I made a time lapse of it in class—I played it for everybody at the start of the next period. I thought they would be like, "Okay yeah, we saw it, whatever." But they were like, "Whoa," so that was cool.

Lark had a positive experience generating student interest in their experiments by creating media and using it in his teaching. He also took multiple photographs of students' small group whiteboards, both to support himself in understanding student thinking and to show the students their progress:

> I use my phone to capture either what students already know, or want to know. I refer to it later in class ... I might just put one of these pictures up on the projector and I'd say, "Okay, last week we wanted to know why bacteria spread fast. Can somebody answer this really quick, so we can feel like we can check it off?" They talk about it. They give a good answer. And I'm like, "Okay. Great." And we cross it off.

These examples from different participants suggest that mobile phone technology provided opportunities for the preservice teachers to document student work and other material for use as meaningful information for their teaching practice.

Student Teaching Sequences

My analysis of the preservice teachers' use of technology as lead student teachers during their winter student teaching reveals that they created and routinely engaged in specific sequences of technology use to complete specific goals. These technology sequences are important to explore: they not only expand the scope of the research to include multiple devices and programs but also allow for a more nuanced understanding of the connections between preservice teachers' digital practices. In many cases, the preservice teachers conceptualized their goals (e.g., plan a lesson) as containing multiple tasks mediated by digital technology. These tasks built on each other and required the use of numerous Internet sources and applications.

The sequences of technology use that emerge from the data show that the preservice teachers engaged in series, or sets, of technology use. The series could include 2–3 electronic devices and up to 6 digital applications. In addition, their chosen sequences were determined by (1) time of day, (2) available technologies, and (3) goal(s) and task(s). The preservice teachers engaged in their technology sequences in the early morning (at home or in transit), mid-morning through afternoon (at school), or at night (at home).

Personal Life Sequences

While at home in the morning or in transit to school, preservice teachers focused primarily on what Lauren called "personal life management" technologies. All the preservice teachers used their phones and alarms to wake up, then engaged with a variety of media, including social media, emails, text messaging, and music or podcasts as they prepared for their

school days. For example, Dylan, who was very routine-driven, described their morning routine with the Buzzfeed, Facebook, and Instagram mobile phone applications, allowing them to find the most current information on a given topic:

> Generally, if I'm on one of these on my phone, I'm on all three. Because it's a routine and, legit, check this out. They're in a triangle on my phone. Let's say, today I started with Buzzfeed and it's so much focus on the tragedy in New Zealand, that I'm like, "Actually, you're not updating me enough." So, I go to Facebook. Because [with] Facebook, I'm not looking for what people say, necessarily, in a personal way. I'm really scrolling for new information. I go to Facebook because Buzzfeed's not refreshing enough. I go back to Buzzfeed just to check, or literally out [of] muscle memory. [I] go back to Buzzfeed, and then I'll be like, now I've looked at both of those things, it's like "I don't want to look at that anymore." And then I'll go to Instagram.

We can use Dylan's example to better understand how the preservice teachers used their short sequences of technology use in terms of factors listed above: time of day, available technology, and individualized goals. First, Dylan's sequence was bound by their three preferred apps, and since they usually engaged in this sequence on their way to school on the bus, it was also time- and location-sensitive. Second, they used the available technology on their phone, and third, they had a specific goal in mind: in this case, to find out the most current information about a tragedy in New Zealand. Dylan's sequence comprising three applications is significant, because it indicates that they developed a personalized routine for information searching that included multiple media and built off prior experiences of using apps to seek relevant information.

Sequences for Teacher-based Goals

A majority of the technology-use sequences described by the preservice teachers were connected to teacher-based work such as lesson planning, teaching, and assessment. The preservice teachers developed these sequences based on their preferred patterns of technology use and the contextual conditions of their school. The latter can include the planning practices of mentor teachers, preservice teachers' accountability to other teachers in their departments, the

learning management system used by the school, and technology norms *set out by* mentors. Most notably, the preservice teachers navigated these factors and created long sequences comprised of devices and multiple media to plan their lessons. Their lesson planning either took place at school or at home, with the preservice teachers using software applications that fit into these five categories: web searches (information, videos, images), word processing (lesson plans and worksheets), presentation (creating new presentations or adapting existing programs), sharing work (mentor feedback), and making work available for other students (posting on learning management systems). While these five categories are present for all of the preservice teachers, they used them in different orders and with a variety of applications.

Perl provides a helpful example of a preservice teacher who developed and practiced different sequences rooted in the categories listed above. Undergirding her technology sequences were what she called "constant" devices and digital programs that she used all day, such as her tablet, an email-pausing service, Dropbox, One Drive, and Google Drive, as well as her school email service. Perl distinguished between her lesson planning, teaching tools, and after-class uses of technology in her paper artifact (see Figure 17). To meet her lesson-planning goals (see middle area of Figure 17), Perl began her sequence of technology use with Google search to locate images to alter, Microsoft Word documents to create worksheets and other student resources, Google slides to create a presentation, and Google Docs for sharing student information with her mentor teacher; she completed the sequence by moving her resources to One Drive for the geometry team to access. We see here that Perl created lesson-preparation sequences that she regularly repeated, achieving her goal of creating her lesson plans and resources while using tools utilized by her school. I highlight her sequence of tools to show how preservice teachers leveraged multiple devices and applications to create lessons that required

multiple components and that were made accessible to other educators.

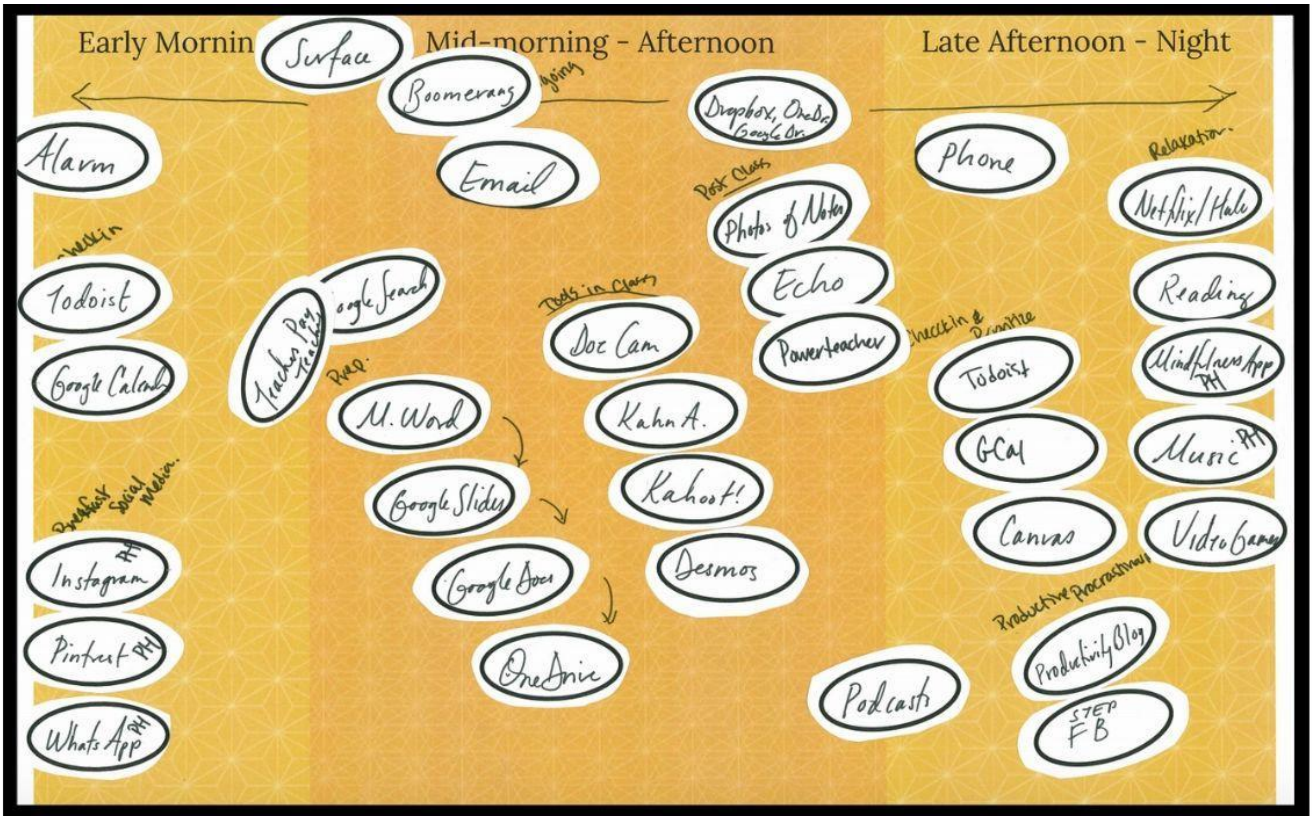


Figure 17. Perl's cycle of devices and applications created during her winter interview.

Sequences Developing into Routines

In addition to underlining the importance of how preservice teachers developed sequences of technology use, it is also significant that most of these sequences became routines. For example, when discussing her lesson-planning sequence, Lauren noted, "It was like this cycle [that] went on for eternity. It was Google search, make a PowerPoint, more tabs, move it to the OneDrive, on repeat." The other preservice teachers shared similar sentiments about how their sequences of lesson planning became routine parts of their student teaching experience.

Chloe suggested that she repeated her preparation and teaching sequence on a daily basis.

Lark echoed that experience, saying, “it’s sort of a cycle that resets every day.” Thus, we must pay close attention to how the devices and media used by preservice teachers worked to enable or constrain their thinking about teaching and learning. It may prove to be the case that digital technologies mediated their thinking processes and became part of the foundation of their teaching practice. For example, Lark and Lauren’s mentors used specific applications to plan their lessons, which in turn shaped how they planned them. Lark’s mentor re-used and altered a daily agenda for each class that was embedded into their learning management system. Therefore, during his student teaching experience, Lark adopted this practice, and it may have shaped how he understood the timing, objectives, and learning activities in class.

For Lauren, her mentor did not write formal lesson plans; rather he used his PowerPoints to organize his lessons. This raised questions for Lauren, who noted:

> Power points were really central. I started to wonder if they were too central. Like what would I do if I didn’t have this or how could I be better if this was taken away? Because it is like a crutch. But once I felt comfortable it was like, do I need the crutch as much as I think?

In summary, the preservice teachers created individual sequences of technology use in their student teaching placements with a combination of the digital programs they preferred (e.g., Google Docs and Slides) in conjunction with specific school-based tools (e.g., Echo and PowerPoint). It is also notable that over time, the preservice teachers’ sequences of technology use developed into trusted routines.

Discussion

The findings presented in this chapter address my second research question: how did the preservice teachers use digital technologies to support their participation in the different settings of their teacher education program? This research question invites a closer look into how the participants interacted with TEP contextual factors and used their digital tools to mediate their

engagement. Specifically, the findings presented here illuminate the various expectations teacher educators established for the participants in university and student teaching classrooms and how such expectations impacted preservice teacher technology use. In addition, this chapter has explored how preservice teachers used digital tools to mediate their interactions with course assignments and with other actors, such as peers, university faculty, mentor teachers, and their own students.

Participating as Graduate Students

My data analysis suggests that as graduate students, the preservice teachers' participation came in the form of interactions with their assignments, engagement with teacher educators and peers in small- and whole-groups, and informal relationships with their peers. Therefore, reinforcing a foundational concept in teacher education, teaching is interactional (Russ et al., 2016).

The participants, as graduate students, used digital tools to mediate their interactions with their assignments (e.g., using the Internet to research information), a finding that is not surprising given what we know from prior research: preservice teachers use digital technology to facilitate their assignment completion, with notable examples including the use of videos to make visual representations (Barak, 2017) and blog posts to facilitate personal reflections (Boulton & Hramiak, 2014). More surprising in my findings is how the preservice teachers described using various digital tools to support their personal learning needs: over the years, as adult learners, the preservice teachers developed solid understandings of what they needed to engage in and complete their assignments successfully. This finding connects to research on self-regulated learning and the ability of learners to be active participants in setting goals and monitoring and supporting their own progress in light of environmental conditions (Pintrich, 2000). Next, I

explore how the concept of self-regulated learning helps explain the preservice teachers' use of digital tools to support their learning needs.

Preservice teachers as self-regulated learners

The preservice teachers who participated this study each articulated what they needed to complete their individual assignments from TEP courses. While my dissertation does not account for all TEP learning episodes, the data does provide preliminary findings about the preservice teachers' perceptions of their learning processes. As discussed earlier in this chapter, the preservice teachers self-reported their approaches to assignments during and after class periods, and these accounts demonstrate differing levels of self-awareness about their learning and how selected strategies aligned with their needs (Kramarksi & Michalsky, 2009). Research on self-directed learning highlights the ways in which students participate in resource-management strategies to support their learning (Zimmerman, 2008). Resource management can include students structuring their time and organizing learning spaces (Pintrich, 1999). The findings in this chapter provide multiple examples of preservice teachers being aware of their strengths and limitations in managing their learning resources.

By focusing on the resource management aspect of learning, we can also expand our understanding of preservice teachers learning to include the everyday-type of digital tasks that support their learning goals, such as time management and desktop organization. It is notable that in these examples of the preservice teachers interacting with their course content, they had autonomy with regard to which digital tools they chose to use. Although the findings show that the preservice teachers selected their digital tools to ameliorate limitations in their learning processes, I cannot comment on their strategies' effectiveness. More research into preservice teachers' use of self-regulated learning strategies in their TEPs (Senler & Sungur-Vural, 2014)

and how they leverage digital technologies to serve their goals is needed.

Participating as Co/lead Teachers

The participants progressed from their roles as graduate students to become co/lead student teachers in different school-based communities of practice. All of the participants were placed in different schools with their own unique contextual factors, including school structures, departmental teams, mentor teachers, and students (Horowitz et al., 2005). While some preservice teachers found congruence between their ideas for teaching and learning and their mentor teachers' practices (Windschitl et al., 2020), others found tensions (Smagorinsky, 2004). Because of their newcomer status, most preservice teachers were amenable to using their mentor teachers' preferred digital planning and teaching tools. External contextual factors such as access to technology (Li et al., 2015) and effective modeling (Sadaf et al., 2016) may contribute to explaining the preservice teachers' willingness to take up their mentors' planning and teaching technologies.

While research shows that external contextual factors such as access, support, and time are important elements in predicting whether preservice teachers will use technology in their student teaching placements, this research tends to focus on student-facing technologies such as blogs (Boulton & Hramiak, 2012) and social media (Szeto & Cheng, 2016). I believe that my research contributes to what we know about preservice teachers using technology in their student teaching placement by expanding our view to include how digital tools facilitate interactions with mentor teachers. My findings indicate that some mentor teachers guided their student teachers in using lesson plan technologies such as PowerPoint and learning management systems to frame how the candidates thought about lesson planning. My findings also show that mentor-mentee relationships were sometimes messy across virtual and in-person modalities, revealing

that mentors and preservice teachers incorporated multiple modes of communication in their work together. My findings also indicate that as the preservice teachers progressed from co- to lead student teachers, they began to adopt a critical eye toward their perceptions of the limitations of their mentors' practices and they integrated their own digital tools and preferences into their planning and teaching. In the next chapter, I explore more examples of how preservice teachers exercised agency in using digital tools.

CHAPTER 8

Preservice Teachers' Exercising Agency with Digital Technology

In this chapter, I explore how preservice teachers exercised agency to choose technology during their TEP. I conceptualize agency as sociocultural processes of thinking and acting that are mediated (Wertsch, Tulviste & Hagstrom, 1993), temporal (Emirbayer & Mische, 1998), and relational (Edwards, 2005). As such, preservice teachers can gauge their ability to participate and then intentionally act for desired outcomes using cultural resources in a given social context. I am interested in examples of agency in which the participants examined the contexts of their student teaching classrooms and took active steps to make changes to enact their vision of teaching. In this chapter, I propose that preservice teacher agency emerged from complex negotiations between their prior technical experiences, community-based expectations for participation, relationships with teacher educators, and the goals they wanted to accomplish.

Negotiations with Mentor Teachers

In this section, I explore how the relational aspect of agency in which other people in the community affected the preservice teacher's capacity to act (Lipponen & Kumpulainen, 2011). The actions of the preservice teachers in this dissertation were shaped partly by teacher educators' expectations and preferences. Although I touched on teacher educators' influence in previous chapters in terms of creating parameters for interactions and the use of specific digital tools, further exploration of preservice teachers' relationships with their mentors is warranted. My analysis reveals the uniqueness of each of the preservice teachers' student teaching experiences with their mentor teachers. Key differences between student teaching placements arise from such factors as preservice teachers' relationships with mentors and other on-site educators, variability of opportunities and support for choosing subject-area content and

instructional strategies, and the types of technologies available for planning and teaching. The diversity in the preservice teachers' experiences with their mentors provides a challenge in presenting cross-case analysis, as there is limited consistency found among the placements. However, each case stands as a rich example of how the contextual factors of relationships and learning environments can impact a preservice teacher's capacity for actions.

The Complexity of Working with Mentor Teachers

The participants navigated the complexities of their student teaching placements to exercise their agency in using technology. The science preservice teachers, Lark and Chloe, for instance, had similar opportunities for choosing science content and instructional strategies. However, the two participants had very different levels of support from their mentors, and I argue that this difference impacted how they carried out their actions. Lark described how his mentor did not have formal teacher training and therefore saw their relationship as mutually beneficial. Lark's mentor said, "I can learn from you (Lark) while you're learning in your [university] classes, I want you to tell me [what you are learning] because that's a lot of stuff I missed." Lark felt supported by his mentor to experiment with instructional strategies for science-based and community-building exercises. Lark's mentor's collaborative approach impacted Lark from the start; he said, "because [my mentor] approached it with humility and really set it up like a partnership from the very beginning, it made me feel supported, especially early on, it gave me more confidence. I was, obviously, pretty nervous." The data reveal that even when Lark's ideas diverged from his mentor's ideas, they were able to engage in constructive conversations to support Lark's development.

Chloe, on the other hand, had a difficult relationship with her mentor teacher and she wanted to leave her placement from the beginning. During the fall quarter, when Chloe was

working as a co-teacher with her mentor, she was not encouraged to include her ideas in their lessons and found working together a challenge. Chloe understood her student teaching experience as a time to practice what she learned in her methods class: "This is my opportunity to actually do what I learned, so I don't want to miss this chance." As a fierce advocate for herself, Chloe developed a different strategy for working with her mentor. She stopped asking for his advice and simply made her own decisions. She described an example of wanting to play music while the students were working:

> My mentor teacher really doesn't like putting music on during class. There's one time, I asked, "Can I just put music on when they're doing their work?" He said, "No." That's why I don't ask because when I ask and he says no, then I cannot do it ... so I do not ask. I just do it and then he will find out. If he figured out it went well and it's not too bad, he might agree on that.

Chloe felt that she could not go directly against her mentor, so she stopped asking for permission because she believed in the soundness of her ideas and was willing to face the consequences. These experiences reported by Lark and Chloe suggest that it is not just one contextual factor that influences their capacity to act; rather it is the interaction of multiple factors.

Negotiating Differences in Mentor-Teacher Relationships

Perl's student teaching experience also warrants further explanation. Unlike the other preservice teachers, she was in a dual student teacher placement where she shared a mentor with another mathematics cohort member. The dual placement caused confusion for all involved, as Perl felt like her mentor did not clearly structure her ramp-up to full-time student teaching. That said, however, Perl also described benefits of having a peer in the room to work with and discuss experiences, and the pair together advocated for themselves with their mentor:

> I think this was something that having another student teacher in the room helped with, because [Tesa] and I would be sitting there alone in the room, and we were like ... "I feel like we're not getting this experience," or, "Do you think it would be useful if our mentor teacher did ...?" So we just kind of tested it out with each

> other, and when it was like, "oh, yes, yes, definitely," we'd say, "Okay, let's talk about it with our mentor teacher after school today."

Perl showed other examples of exercising her agency when she approached her mentor about lesson plan ideas. Their typical process would unfold like this:

> We can come to our mentor teacher with ideas. She'll be like, "That's awesome. I know why you're thinking about that, but this doesn't work in practice. And here's why my six years of experience taught me that." But she's also open to us pushing back on it. So, I brought her a lesson, and she said, "I don't think this is going to work," and it was super disappointing for me. But I reworked it and came back and made a really solid argument backed up by theory on why it worked, and we went through it. She's like, "Okay. We need to scaffold it for practical use," and so we had that conversation about bridging the theory and the practice.

Perl exhibited persistence in negotiating her teaching practice with her mentor. Not only did she have the capacity to suggest ideas to her mentor, but Perl also showed the determination to return with research-based ideas to convince her mentor to move forward with the strategies. And in some cases, Perl received her mentor's approval to implement the lesson.

Summarizing the Landscape of Mentor-Teacher Relationships

Thus far, I have presented short descriptions of three of the six preservice teachers and the variations across their student teaching placements. Each placement was different, with complex relationships between the mentor teachers, the preservice teachers, and their subject area content and teaching strategies. These three examples show a range of negotiations; Lark engaged in supportive co-planning conversations; Chloe advocated for herself and stopped asking for permission; and Perl discussed her ideas, backed them with evidence, and only proceeded when approved. The remaining three preservice teachers (Lauren, Natalie, and Dylan) seem to land closer to Perl's experience. They had personalized ideas for new lessons, but they tended to defer to their mentors' styles and did not advocate for sizable changes. The details

about each preservice teachers' experience with their mentor teacher sets the foundation for us to understand their agency in using digital technologies.

Exercising Agency to Improve Teaching

While in their student teaching placements, the preservice teachers exercised agency to use technology to achieve goals related to their teaching practices. Most goals and actions were concerned with improving their work as teachers. Examples included the use of technology to increase the effectiveness of their actions as teachers and to enhance collaborations with mentors and other faculty. Within these two areas, the preservice teachers described how their behavior pushed past the established norms of their student teaching classrooms.

Increasing the efficiency of their practices

As the preservice teachers spent more time in their student teaching placements, three of them came up with ways to use technology to increase their work efficiency. Lark, Perl, and Chloe described using technology to accelerate the completion of specific teaching tasks or actions. Lark explained an example of using technology to expedite one of his mentor's lessons to investigate song lyrics about drug use. Lark described his mentor's slow process of looking up each song on YouTube, which prompted Lark to suggest a new program:

> I told my mentor that looking each song up on YouTube takes a really long time. I'll just make a Spotify playlist, and it'll already be ready to go. We'll just click through the Spotify playlist and you don't have to search for the song. And sometimes you find one on YouTube but it's been banned by copyright, so it's silent and it doesn't play. We can avoid all of that with Spotify. I have an account, I made a playlist, and it was good to go.

Lark used his prior experience with a specific audio streaming platform to increase the lesson's planning speed and the accuracy of the songs, and he suggested to his mentor that he update his teaching practice by integrating a new digital tool. Perl and Chloe also leveraged their experiences with technology to make the most of their teaching time. While Perl did not have the

opportunity to experiment with many new technologies in her placement, she did find ways to use her preferred devices and programs to accelerate the work she had control over. For example, during each class period, her students could earn participation points. Her mentor documented these points by hand and then entered them into the electronic grade book. To expedite the point-recording process, Perl began carrying her tablet to note the points electronically. However, Perl was limited by her mentor's style, and she could not wholly execute her vision for electronic grades. She commented, "if I were doing just myself in the classroom, I would just mirror my screen up [to the front of the room] and enter them as I'm going around." See the photograph labeled #1 in Figure 18 of Perl's point system. In this case, Perl had the technical knowledge to enact her idea for using her tablet, but the contextual factors of her placement limited her.

Advocating Through Adversity. Chloe experienced similar limitations to Perl's, but she continued to advocate for herself and acted on her desire to learn to use new technologies to improve her teaching. For example, Chloe noticed that her mentor's classroom was fitted with an interactive display Smart Board in the front of the room. She wanted to learn how to use it, but when she inquired with her mentor, he did not support her efforts to understand the tool:

> He even recommended that I not use the Smart Board. [He said] "first you don't know how to use it, you will mess up because you don't know how to use it. It's not like you already know how to use it.

Not only did her mentor not support her using the tool, but Chloe's report of their conversation also shows him predicting her failure. Chloe showed again that she believed in herself and her ability to learn new technologies when she responded to her mentor by saying, "I want to have a try ... I can come to school early. I want to practice using it. I will learn it—either at Cascade University, or online." Her mentor eventually agreed and Chloe engaged in a multi-step process to learn how to use the Smart Board. She utilized the resources she was aware of, beginning with

the TEP's technology center. There were complications with the technology center and they were ultimately not able to help Chloe access the Smart Boards on campus to practice. This setback did not stop Chloe; rather, she said to herself,

> I will figure it out. I used YouTube, that saved my life. I [searched] 'How to use a Smart Board,' it taught me how to use it. The very next day I went to school very early just to practice using it and try what I learned from YouTube, and it worked.

After Chloe learned how to use the Smart Board, she used the tool's affordances to change how she designed and used her PowerPoint presentations. She intentionally left space in her slides to draw and write on them using the Smart Board pen. In terms of making her teaching more efficient, she streamlined her students' model-making process by guiding their drawing steps with her examples on the Smart Board.

Chloe's learning episode with the Smart Board is significant because it shows her exercising her agency to complete a goal that spans multiple settings. First, she advocated for herself in the face of solid pushback from her mentor, then she sought assistance from the technology center. Chloe continued her journey by searching the Internet to find resources to teach herself, and lastly, she circled back to her mentor's classroom to practice before her lesson. Her commitment to learning and using the technology tool reinforced her previous comments about taking advantage of her learning opportunities as a student teacher. Her capacity for setting goals and attaining them through multiple means stands out as a cornerstone of her learning trajectory as a preservice teacher.

Identifying Limitations and Changing Course. In juxtaposition to Chloe's actions to learn how to use the Smart Board, Perl had a similar interest but she did not act on her inclination. Rather, she acknowledged and accepted her mentor's control over the classroom space:

> I had mentioned getting our Smart Board working a few times. And [my mentor] has just not bought into that, and I don't know why. I think that's just because she had never fully used her Smart Board. I wasn't really bringing a huge amount of technology into the classroom…it was kind of understood, an agreement that we would go with what [my mentor] did.

Perl had the training and the interest in learning how to use novel technologies to improve her teaching, but unlike Chloe, she did not pursue it with her mentor. These two examples of preservice teachers wanting to learn how to use the same technology raise questions about the relational factors that may have impacted their agency. Both Chloe and Perl knew what they wanted to learn, but while Chloe worked through the tension with her mentor, Perl accepted the parameters of her placement.

Improving Collaboration and Communication

Next, I describe how three preservice teachers used technology to accomplish goals concerning their communication with their mentors. The preservice teachers described their uses of different digital programs to organize their teaching schedules and student assessment practices such as grading and attendance. For example, Perl, who we know as a preservice teacher who actively worked to organize her schedule, suggested that her mentor create a Google Doc to-do list to keep track of their shared teaching schedule. Although Perl commented that both her school and mentor were "amazing" to work with, she acknowledged that her mentor was not necessarily an organized person. Perl proposed Google Docs because the digital tool allowed easy creation and sharing within their triad teaching team. Perl described a screenshot of their winter quarter to-do list:

> This is an emptier to-do list than is normally in there, but there are different categories. This was shared between [my peer, my mentor, and me]. We all use different to-do list applications ... but we needed some place to have shared stuff for the classroom.

Perl seemed to feel more comfortable with a clear and organized schedule, and she deliberately took steps to develop a shared scheduling system with her co-teachers. She remarked that they continued to use Google Docs to organize their work, and in some cases, her co-teacher created the documents. See the photograph labeled #2 in Figure 18 for an example of their to-do list.

Digital technology was not always a mediating factor in the preservice teachers' achievement of agency in terms of communication. Lauren for example, experienced a pivotal moment in her relationship with her mentor in which her mentor did not give her effective lesson plan feedback that she requested, and her state required edTPA lesson was not as successful as she hoped. Lauren walked away from that experience quite jaded and looked for other mentorship in her department. She developed a mentor relationship with another social studies teacher who exposed her to pedagogical approaches that her assigned mentor did not use, such as community building strategies and tips for teaching writing. Lauren described their relationship thus: "she wasn't my chosen mentor, but I feel she filled that gap for me because she was just so nice and relatable and also really intense and also [in the office] really late. So anyways, I love [her]." Even though Lauren did not provide many examples of using technology in agentic ways with her mentor, she acted without technology to find the mentorship she needed. Therefore, it seems that some preservice teachers exercised their agency both in ways that included technology, when relevant, and in ways that did not.

Adding Media Content to Improve Teaching Quality

In Chapter 7, I described the ways that the preservice teachers added content to their lessons to improve student engagement and relevance by offering them visualizations of concepts they could not access without technology. Here, I look at the preservice teachers' actions using digital technology through the lens of challenging current practices to improve

teaching. The preservice teachers described instances of adding subject-matter content to modify existing lesson plans and resources, as well as creating content, lessons, and instructional strategies that were not previously part of their mentors' curriculum. Natalie's and Lauren's experiences provide examples of this type of content-creation behavior. Their mentors' teaching styles constrained both preservice teachers, but they both claimed sufficient agency around the edges to add digital content to their lesson plans and resources. For example, Lauren was tasked with making PowerPoint presentations, and she chose to devote extra time to the work, making the slides to her liking:

> I'm really into making PowerPoints look nice and my mentor teacher loves PowerPoints, but he would never spend the time I spend on them. I think my mentor teacher has been around too long.

Lauren identified other differences between her practice and that of her mentor, too, such as when she talks about using Google Docs and how her mentor refused. Their high school students used Google Docs, and Lauren used it with them, but not with her mentor: "I think Google Docs is a great platform for sharing and collaborative work, but my teacher does not. I feel like it's a learned practice." In this case, Lauren did not push the issue with her mentor, instead focusing on using it in her university-based coursework assignments.

Finding and Modifying Media. The preservice teachers also found digital media and adapted it to better align with their ideas for teaching and student learning. Lauren described her process of finding resources to modify for her social studies lessons: "I Google and search forever, an eternity, it's so much time, so much time looking for the right document, the right thing. Then rewriting things to be appropriate for kids." While Lauren Googled for text-based documents to modify, Perl and Chloe searched for graphics and photographs to use in their worksheets and presentations. Perl described her process in creating a worksheet for her

geometry class using a boot print:

> I was looking and looking for something that had a triangle in it, and so I'm just Googling boot prints and things like that. Finally found one that I could alter, so I had one boot print I used in seven different diagrams in this lesson plan.

Both Lauren's and Perl's accounts show deliberate alterations of digital media in their lessons. Like Lauren and Perl, Chloe also searched the Internet for digital media that closely aligned with her ideas for visually supporting her students' learning. In some cases, Chloe found that she could not locate what she was looking for and ended up making the examples herself: "This is one that I had to make. I had to draw this by myself…because what you want to do sometimes you cannot get online, you have to do it by yourself." As Chloe described, sometimes the preservice teachers had ideas for media that they could not find as pre-made resources. When this occurred, some of the preservice teachers leveraged their skills for making media to create their desired resources. For example, Chloe had developed skills using digital animation programs in her undergraduate degree and during her teaching experiences in Asia. She drew on these skills to create graphics for her worksheets. She commented:

> I have to make some animation, by myself using PowerPoint, Word, or anything that I can use to edit those things. I need to make animations by myself. I use Flash to make animations that rotate just for my class. Because I have to do it. I cannot find anything suitable for my class. I have to make it, to customize it by myself.

What is notable here is Chloe's determination to make visual representations that she wanted for her students. Throughout our interviews, Chloe was relentless about making what she needed for her teaching, and she would not accept anything less for her students.

Other examples of preservice teachers exercising agency using technology to add content include and adding memes, photographs, and videos. For example, Lark created memes to add content to his lessons and encourage students to read the slides. He used an online meme

generator to create memes to connect to his students' interests. Lark even included language he heard his students using in class. He explained his process thus:

> There's this saying that I heard a bunch of teenagers using and I had to have one explain to me. They say, "Let's get this bread." I'm like, "What does that mean?" Apparently bread is money, so it's like, "We're going to hustle today, we're going to get this money." In class, we were going to cover asthma inhalers and how they work. So I found a picture of an inhaler and it said, "Let's get this breath" instead of "Let's get this bread." I thought it was hilarious. Like, one kid laughed really hard and the rest of them were all eye rolls.

Lark expected a high number of students to roll their eyes when they read the meme, but their responses showed him that they read the slide, "they groan when they read [the memes], but that's my intended response. I'm like, well, at least I know you read it." This example illustrates Lark's approach to his work as a teacher. He is earnest in his interest in learning more about his students' lives and increasing their participation in science-based content.

Additional examples of adding digital content include preservice teachers use of Internet-based websites and simulations, phone applications, videos to add diverse voices in the classroom, primary and secondary sources, and different class-community-building exercises. In some cases, the preservice teachers experienced the inclusion of these examples as graduate students during their university coursework. For example, in her science methods course, Chloe's professor demonstrated a sound wave unit using a specific mobile phone application. See the photograph labeled #3 in Figure 18 for the wave application. Inspired by that experience, Chloe designed a wave lesson with her students in which she had them download the application and use it outside in a big field adjacent to their school building. Chloe's mentor did not use this type of technology in the classroom, and Chloe was determined to have the students engage in the experiment. She sent two Schoology reminders to download the application and to dress for the rainy weather. Here's Chloe's description of her students' engagement with the lesson:

> The students did the wave modeling and they talked about it in the field and did the experiment. Back in the classroom they actually initiated a lot of discussion with themselves even without my facilitation. They talked about the process, data, how to analyze the data, what they found out from the data.

Chloe attributed the design of this lesson and other lessons to the Ambitious Science Teaching that she learned in her university-based courses. At the end of the quarter, she described a change in her mentor's attitude towards her teaching. She said that he could see the level of student engagement, and in the end, he asked her for copies of her lessons.

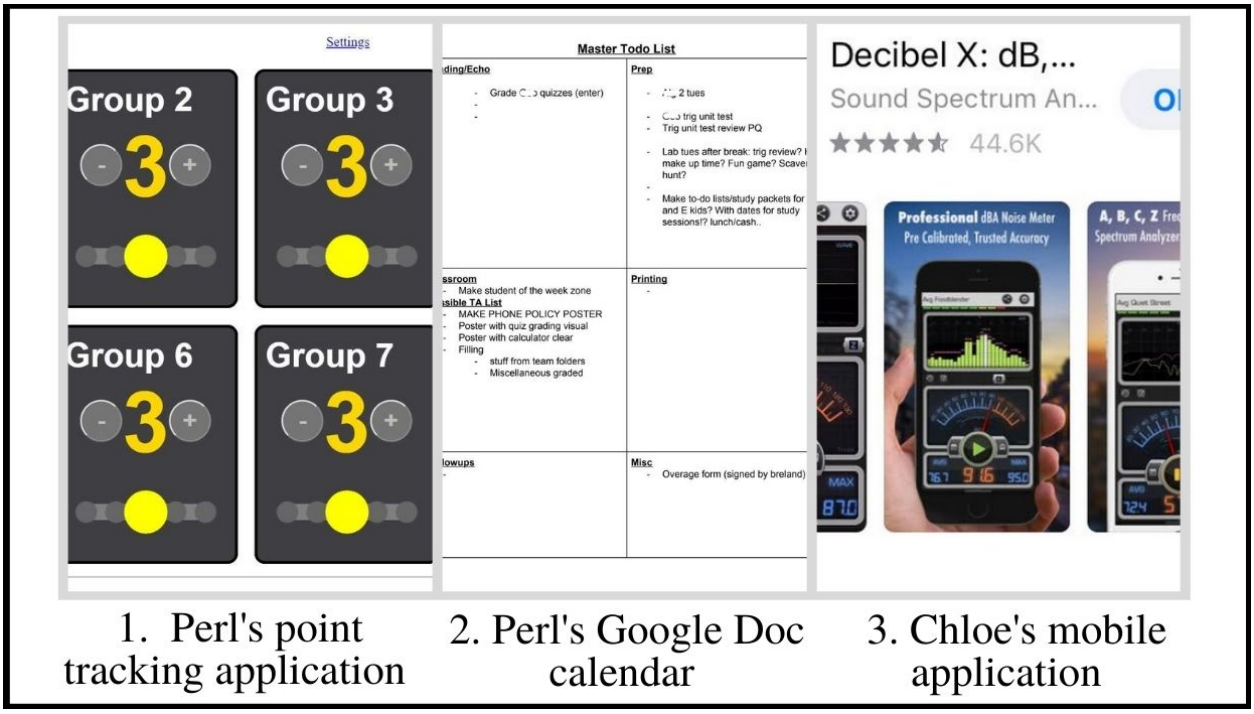


Figure 18. Three examples of preservice teachers using technology to improve their teaching.

The Puzzle of Dylan's Agency

Throughout this chapter, Dylan was not mentioned much in the findings. My data analysis shows that in their mentor teachers' classroom, Dylan did not engage in many agentic actions—with or without technology. This was surprising to me as I had come to know Dylan as

a confident graduate student with strong opinions about being a social justice educator. When asked about their opportunities to contribute ideas to their unit plans, Dylan responded:

> I think this is one of the hardest things with my mentor teacher. I don't really do very well with folks who don't actively seek my opinion. Because of my Libraness, I'm so flexible and down-to-jive and people please-y. I hear what she wants and I do it that way, but because she doesn't say, "How would you do this? What are your thoughts?" She rarely says that, so I don't get the opportunity. I need someone to make space for me in order to readily do that. Or else I assume you don't give a shit. If you don't give a shit, I'm not going to spend my time.

Dylan was given opportunities to make PowerPoint presentations, but they didn't consider themselves creative and did not include many visuals in their slides. While Dylan did not engage in the visual aspect of creating instructional media, they were interested in adding music to the classroom. Playing music was not a practice employed by their mentor. Dylan described an instance of playing music when they were the substitute teacher in their student teaching classroom. Dylan described the result of exercising agency to play music:

> I played music through the passing period, so it's not like I stopped it at the end and then started it. The tempo of the music [was helpful], especially for sixth period, which is our really challenging period. Especially because I was alone as the substitute. The students needed that music. They responded to it.

This example shows an instance of Dylan using music, something central to their life, in their teaching. It resulted in a memorable experience for them and possibly for their students.

In this subsection, I've provided examples of the preservice teachers' acting within the contexts of their student teaching classrooms to add subject-area content and create lessons and resources that were new to their students. These examples suggest that preservice teachers used experiences gleaned from university courses, technical skills, and individual teaching preferences to shape how they leveraged technology to personalize lessons to meet the needs of their students.

Discussion

The findings presented in this chapter help inform our understanding of the complex nature of preservice teachers' participation in TEP communities of practice by focusing on their agency. I used a sociocultural perspective of agency (Priestly et al., 2015) to frame it as facilitated process in which preservice teachers' prior histories and current understandings influenced their capacities to act intentionally using the available cultural resources in their social contexts. I am also interested in how preservice teachers imagined alternative solutions and formulated goals to guide their agency (Emirbayer & Mische, 1998) to comply with or resist the practices and norms of the groups in which they are participating (Gresalfi, Marin, Hand & Greeno, 2009). The findings in this chapter suggest that the agency of preservice teachers was mediated by the contextual conditions of their classroom communities, as well as by their own unique internal factors.

Influential Contextual Factors

The findings in this chapter provide a nuanced look into the contextual conditions present in student teaching classrooms and how these factors worked to enable or constrain preservice teachers' capacities to develop and enact their visions for teaching. My data analysis suggests that preservice teachers navigated complex student teaching placements composed of influential contextual features such as people (i.e., mentors, students), student teacher expectations (lesson planning, enactment, and assessment), and available technology (hardware and software). Thus, preservice teachers' abilities to act are situated processes in which "actors always act by means of an environment rather than simply in an environment" (Biesta & Tedder, 2007, p.137, emphasis in the original). Therefore, the contextual factors present in student teaching classrooms are essential to understanding preservice-teacher agency. Consistent with prior

studies on preservice-teacher agency (e.g., Meierdirk, 2018), my findings suggest that these contextual factors are not isolated influences. Rather, they are interconnected to compose a complex social plane in which the preservice teachers imagine goals and perform actions to achieve these goals, to differing degrees, with and without technology. Variation in the web-like quality of the contextual factors also created the conditions for preservice-teacher agency to be mediated by relational and temporal qualities.

Relational Qualities of Preservice-Teacher Agency

The sociocultural view of learning that undergirds this dissertation highlights the relational aspects of participation and agency. In this view, interactions with other people are considered part of the cultural resources that mediate individual agency (Lipponen & Kumpulainen, 2001), and agency therefore evolves on a social plane, where preservice teachers understand their abilities to act in relation to others' thoughts and actions (Edwards, 2005). A key finding from this chapter is the significant role mentors played in creating opportunities for preservice teachers to share and enact their ideas in student teaching classrooms. This claim aligns with other studies showing the hierarchical relationship between mentor teachers and preservice teachers, with the mentors controlling much of the conversation (Canipe & Gunckel, 2020). The findings in this chapter contribute to what we know about preservice teachers' perceptions of their mentor-teacher relationships. Specifically, my analysis provides evidence for how preservice teachers understood their capacities to act based on their negotiations with mentors.

Tensions in Mentor-Teacher Relationships. While many variables impact such negotiations, my findings highlight the importance of the concordance versus discordance of preservice teachers' ideas about teaching with those of their mentors. By this, I mean that when a

preservice teacher's ideas aligned with their mentor's, there seemed to be less of a need for the preservice teachers to advocate for their ideas about technology use. Research into relationships between preservice and mentor teachers has revealed the impact of alignment of teaching visions (Windschitl et al., 2020) and tensions between preservice teachers' desires to implement university-based approaches and mentors' practices (Anderson & Stillman, 2013; Hebard, 2016). In some cases, using a specific instructional tool is a central aspect of the dissonances between the preservice teachers and their mentors (Smagorinsky et al., 2004). The findings in this chapter suggest that preservice teachers' desires to use novel digital tools to enact their visions of teaching can cause contention in their relationships with their mentors. Chloe's situation, as well as other cases such as Perl's, provide evidence of preservice teachers feeling torn between trying to enact their own ideas to introduce new digital tools and trying to adhere to their mentors' expectations. However, there are instances in which tension can be productive and where teachers grow from the process of wrestling with divergent ideas (Stillman, 2011).

Working Towards a Mutually Beneficial Relationship. This chapter includes instances of the preservice teachers exercising agency to choose curriculum and digital tools that ended up benefiting their mentor teachers. In so doing, I see the preservice teachers acting as contributing members of the teaching team, and thus progressing from outsiders to more integral members of their communities of practice as when given space to experiment with their ideas and digital tools. In these cases, the preservice teachers negotiated the inclusion of their instructional strategies and contributed to their classroom's planning and teaching, challenging the traditional unidirectional relationship of mentor and student teacher in which knowledge comes from the more established of the two (Canipe & Gunckel, 2020). Thus, mentor-student teacher

partnerships may become more mutually beneficial when preservice teachers are allowed or encouraged to contribute knowledge and experiment with novel tools.

Other Contextual Factors

While the main contextual factors I've explored thus far are teacher educators, such as university faculty and mentor teachers, there are other important contextual factors that influenced preservice teachers' agency to employ digital tools to enact their visions of teaching. Most notably, the findings in this chapter align with previous research showing that availability of technology and support are important factors (Tondeur et al., 2012). My analysis suggests that when technology, such as a Smart Board, is available, some preservice teachers want to use it. However, just having the digital tool is not enough to ensure preservice-teacher agency. My findings confirm previous research in showing that the use of technology by preservice teachers and practicing teachers is a complicated endeavor beset with layers of relational and practical factors (Zhao & Frank, 2003; Tondeur et al., 2016; Admirall et al., 2017).

Preservice Teachers' Internal Qualities

In addition to the numerous external factors that shaped the preservice teachers' technology-related agency opportunities, there were also internal qualities unique to each future teacher. Priestley et al. (2015) suggest that agency "builds upon past achievements, understandings and patterns of action" (p.4). Thus, the preservice teachers' prior experiences with and valuations of technology are of interest when analyzing their agency, and I suggest that the findings of this dissertation support such a claim. In general, preservice teachers' prior digital practices, such as collecting photographic evidence, set the stage for how they thought about using technology to facilitate actions within their novel communities of practice. While this is not surprising, focusing on prior histories with technology opens doors for exploring how

preservice teachers' past ways of acting with technology shaped the goals they set for themselves using it in student teaching classrooms.

Imagining and Achieving Goals

Two particularly intriguing aspects of my data are the differences in how preservice teachers understood the array of actions available to them and the degrees to which they pursued any or all such actions. To account for the differences in their agency achievement, I draw on Emirbayer & Mische's (1998) concept of agency as including individuals' capacities formulate goals to guide their agency. Thus, the goals preservice teachers set for themselves and their commitments to accomplishing these goals may help explain the differences in their experiences across student teaching classrooms. For example, Chloe and Perl both expressed the desire to learn how to use the Smart Board, and their contextual factors were somewhat similar. So why did these two preservice teachers' subsequent actions differ so dramatically? Using Emirbayer & Mische's (1998) concept, I suggest that Chloe imagined what she could do with the digital tool and created a clear goal for herself to meet despite her mentor's response. Whereas Perl, after receiving a negative response, chose to align her actions with her mentor's preferences and abandoned her goal of using the Smart Board, so Perl may not have assigned as much value as Chloe did to accomplishing her goal at that time.

CHAPTER 9

Implications and Conclusion

My dissertation has implications for the field of teacher education—particularly with regard to our understanding of how some teachers learn with technology—and may inform further research and have practical applications for teacher educators and policy makers. I begin by outlining how the findings of my dissertation expand our conceptualization of preservice teacher learning. Next, I describe the implications for further research regarding both unanswered questions and methodological approaches. Finally, I make recommendations for how TEPs, university teacher educators, mentor teachers, and policy makers can value preservice teachers' uses of technology as assets in their learning.

Conceptual Implications

I believe that my research findings can expand how teacher educators and researchers conceptualize teacher learning with technology with regard to preservice teachers' prior histories, reasons for using technology, and agentic moves to contribute to the university and student teaching classrooms. I explore these ideas and how they relate to current research in teacher education below.

Preservice Teachers' Prior Histories: The Foundation of Their Technology Use

I propose that in light of the rise of digital technologies in many aspects of life (Donovan & Hansen, 2011; Garcia et al., 2021)—and the findings in this study—that the teacher education community should consider preservice teachers' past and current digital lives as significant elements of their personal histories that can influence both *what* technology they use in their TEPs and *how* they use it. This dissertation adds to the concept that preservice teachers come with complex digital pasts composed of different levels of access, differing practices, and

disparate value beliefs (Mukama, 2010; Buss & Fulton, 2012; Sadaf et al., 2016; Valtonen & Siegl, 2018). My study contributes to how we conceptualize preservice teachers' prior histories in our current era by calling attention to their experiences with digital technologies and exploring how their digital practices are developed through personal experiences with people, interests, and contextual factors.

Preservice Teachers Choice of Technology: Tools to Meet Their Learning Needs

My findings also contribute to our understanding of *why* preservice teachers use digital technologies while in a TEP. My research adds to this understanding by expanding knowledge about preservice teachers' intentions for using technology. More specifically, my findings highlight the fact that preservice teachers have and act on intentions to choose digital tools to support particular self-identified learning needs during their TEPs. While it may seem quite evident that preservice teachers would choose digital tools based on their needs, formalizing this finding allows us to better understand the areas of support that preservice teachers might seek or require.

The preservice teachers who participated in this study used various digital technologies (in conjunction with other tools in their environments) to support their abilities to engage with peers and teacher educators, search for new information, and create structures and resources for teaching. By facilitating such understanding, this dissertation may help the teacher education community better conceptualize preservice teachers' learning needs, whether social, informational, or pedagogical.

Preservice Teacher Agency with Technology: A Method for Contributing New Ideas

This dissertation contributes to the conceptualization of preservice teacher agency through mentor teacher negotiations in student teaching classrooms. My data analysis shows that

within these unique scenarios, the preservice teachers successfully exercised agency with technology when they displayed strong commitments to achieve their teaching goals. Thus, my dissertation contributes to the teacher education communities' conceptual understanding of how goals impact preservice teachers' agency achievement.

In addition, the results of preservice teachers exercising agency in student teaching classrooms can be seen as contributions to their shared teaching practice with mentors and to their classroom communities. In this view, preservice teachers sometimes brought different perspectives for use of technology that was not currently in place, and they strove to transform both their work as teachers and their students' learning experiences. In some cases, the mentor teachers took up the technologies and integrated them into their work as well. Therefore, this dissertation contributes to how we conceptualize preservice teacher agency in terms of transformative actions that contribute to the repertoire of practices in their classrooms.

Implications for Further Research

By centering preservice teachers' perspectives, my dissertation uncovered the surface of more profound questions that merit further study. It could be beneficial, for example, to invite preservice teachers to reflect more deeply about what factors shaped their thinking about and use of technology within and across the adolescent, emerging-adult, and adult phases of their lives. Specific attention could also be paid to experiences in school spaces, with critical reflection on how participants' elementary, middle, and high school teachers' uses of technology shaped their own various ideas about using it in their learning and future teaching. In conjunction with further studying preservice teachers' prior school-based practices, it might also be helpful to conduct further research into their everyday digital practices as essential skills and routine ways of participating in different facets of work, home, and social life. As researchers continue to study

how teachers' everyday knowledge can support the acquisition of specialized professional knowledge (Russ et al., 2016), we need to know more about the roles that mundane digital practices play in how preservice teachers use tools to support their learning.

Additional Research on Sequences of Technology Use

My findings provide an intriguing glimpse into the ways future teachers employed sequences of multiple devices and applications in their lives and learning, but more research is needed to clearly understand the devices, applications, and practices included in these sequences and how they might change depending on the contextual factors of each TEP setting. In addition, it would be beneficial to look, in more minute detail, at the ways preservice teachers work in and across their different technologies. For example, supposing a given preservice teacher uses Google Slides, Google Search, web-pages, a lesson plan template, email, and their paper journal in their sequences, it would be useful to know how this preservice teacher cycles through these tools to support their work and how their knowledge was distributed and developed among the tools. Thus, further study into the specifics of how preservice teachers curate tool sequences could help us better understand their processes for creating and implementing lessons, and such understanding could, in turn, help teacher educators design their university courses to better support the preservice teachers' learning processes.

More Research About On- and Offline Relationships

The data I collected includes examples of preservice teachers' interactions with mentors occurring in both face-to-face and digital settings. While this was not a major focus of my research, it is a field ripe for further study. The topic of developing relationships in person and virtually has been studied in adolescence (Davis, 2013), yet much less is known about how these multiple modalities shape the interactions between cohort members and their teacher educators.

In order to leverage the affordances of face-to-face and digital modalities to support preservice teacher development during field placements, greater understanding about how communication and feedback develops between mentors and preservice teachers is needed. To pursue such information, future studies could, for example, closely follow both the preservice teacher and mentor during field placement experiences, with careful attention to the types of discourse used within and across each modality, the topics discussed, and how discussions build across time, setting, and modality. Collecting data from both parties would be necessary to develop a comprehensive understanding of their preferences, their intentions, and the results of the relationship building and teacher development.

Further Research on Preservice Teachers' Digital Tool Contributions

The findings of this study include examples of the preservice teachers' leveraging their familiar digital tools in their university courses and student teaching placements. While the data show examples of unique tool use, I expected to see a wider variety of devices and applications employed by the preservice teachers. It seems that they used more emerging and everyday technologies in their lives outside of school than in school spaces. Although these findings align with previous research showing that teachers tend to use existing technologies that are in line with current modes of teaching (Ottenbreit-Leftwich et al., 2010; Tondeur et al., 2016), I had expected that the participants' unique digital lives would be reflected more evidently in their teaching. I would like to further investigate how future teachers think about this disparity and what contextual factors should be present in university and school settings to encourage preservice teachers to suggest and try out everyday and emerging technologies with students. Further research could look at field placements with mentors who use such technologies in different subject areas and then at how preservice teachers respond to it.

Methodological Implications

I see two main methodological implications related to the design of my dissertation. The first centers on the participants' lives and voices regarding technology use: instead of studying the effectiveness of one tool, I expanded the scope of the dissertation to include all of the digital tools, practices, and intentions experienced by the preservice teachers; and I expect, when designing future research in teacher education, that this approach will help account for the ever-changing nature of digital technologies. In order to design responsive studies that value preservice teachers' current experiences and make space for future developments in teacher learning and pedagogical practices, I suggest that preservice teachers should be recognized knowledgeable actors whose expertise with everyday technologies can be infused into current teaching practices.

The second implication for future study designs is based on the data collection procedure that I call Quarterly Digital Evidence. As noted in my methods chapter, I designed this method in response to our pilot study and with inspiration from researchers' innovative data collection procedures in visual methodologies [Mitchell, 2011] and digital ethnography [Pink et al., 2016]. I believe that having the preservice teachers take screenshots or digital photographs throughout the quarter helped them remember their technology examples in greater detail than when answering verbal questions. These artifact-elicited portions of the interviews yielded richer information about the participants' intentions for using their technologies, a result that reinforces the power of visual artifacts in qualitative research to forefront participants' voices and experiences (Clark, 1999; Epstein et al., 2006; Gomez & Vannini, 2017). Based on my involvement with this data collection procedure, I believe it is a relevant approach that deserves

more exploration with regard to its effectiveness as a data collection procedure for studying preservice teachers' digital practices in their TEPs.

Practical Implications

While my study sample was small and primarily focused on preservice teachers who regularly used technology, given the diversity of subjects' backgrounds and demographic factors, I still believe it to be reasonably representative of many preservice teachers. I therefore feel that my conclusions may bear helpful practical implications for TEPs, teacher educators, and policy makers.

There has long been a call for greater technology integration into the curricula and experiences of preservice teachers (Office of Educational Technology, 2016), and my findings showcase how preservice teachers themselves could be positioned as leaders in integrating technology in authentic ways throughout TEP settings. If TEPs worked to make their preservice teachers' existing practices more explicit through encouragement and sharing of resources, preservice teachers might be able to drive technology integration forward in ways that are meaningful and relevant to their needs. In terms of programmatic implications for integration, I have learned from this study that solitary technology courses do not provide enough opportunities for preservice teachers to reflect on their prior uses, to learn contemporary frameworks for teaching with technology, or to practice new tools and skills. Rather, the 'technology course' could be reimagined as a hub for preservice teachers and teacher educators to gather and discuss approaches for using technology in subject-area specific and cross-content ways. Although there is limited time in a year-long TEP, such a class could run throughout the program with assignments and discussions spanning methods courses and fieldwork so that preservice teachers learn and practice novel approaches to teaching with technology.

Implications for Teacher Educators

My dissertation has implications for teacher educators in both university and school-based settings. My conclusions might especially help to inform faculty and graduate student instructors in university settings about how to approach preservice teachers' technology use. The preservice teachers in my sample seemed ready to use familiar technologies to complete assignments and participate in group work when given the space to do so. Teacher educators might therefore consider reviewing their class designs and assignments for ways to integrate preservice teacher agency for choosing preferred devices and applications. It would also be beneficial for teacher educators to talk with preservice teachers about the role digital technologies have in mediating our work and how the tools themselves are not neutral. Teacher educators can work with preservice teachers to critically examine the digital tools in terms of who created them, what biases may be present in the design, and how the formatting of the tools impact the preservice teachers ideas about teaching and learning.

Teacher educators might also consider offering more multimodal options for preservice teachers to show their understanding of taught skills and concepts. Some of the preservice teachers in the study were adept at creating visual media and could potentially benefit from opportunities to show their learning using multiple—and possibly unconventional—modes of communication.

My work also revealed how preservice teachers relied on the Internet to find information and resources for their assignments and lessons. This finding is important for teacher educators because it reveals gaps in preservice teacher knowledge (e.g., subject area information) that compelled them to look to the Internet for supplementation. The participants' frequent use of the Internet to find sources also raises important questions about preservice teachers' media literacy

skills. It may well be that preservice teachers are obtaining information from digital sources that are not as properly vetted as library-based print sources, in which case, TEPs and teacher educators might need to offer media literacy guidance to support preservice teachers in identifying and using credibly sourced materials (Fry & Seely, 2011; Meehan et al., 2015).

Implications for mentor teachers. I contend that my dissertation also has important implications for mentor teachers. Based on my findings, I suggest that mentors can embrace preservice teachers as holders of valuable digital practices formed in and outside of school that can be leveraged during shared classroom work. Preservice teachers may contribute a fresh perspective for using technology based on their unique prior histories of everyday and specialized digital practices, and mentors could benefit from learning with their preservice teachers about different ways to use new and familiar technologies to find information, re-envision instructional strategies, and adapt content to be more closely related to their students' interests. In conjunction with valuing preservice teachers' ideas about using various technologies, mentors could support their development by engaging in thoughtful pedagogical conversations about technology use (Washington OSPI, 2020). I argue that creating a generative and open space to communicate about prior, current, and forthcoming technology use could be beneficial for both mentors and preservice teachers.

Implications for Policy Makers

My dissertation also has the potential to impact policy makers who set standards and allocate fund for technology in teacher education. In terms of national standards for technology in preparing future teachers, the InTASC Core Teaching Standards highlights the importance of preservice teachers' learning how to use technology to plan responsive and rigorous lessons. My findings suggest that the participants were engaging in the beginning stages of this technology-

supported planning practice and they might have benefited from more opportunities to work with more faculty and mentors who modeled innovative ways of using technology to design and implement responsive and engaging lessons. Policy makers could add language to existing standards calling for increased opportunities for teacher educators to develop technology-based creative teaching skills and then explicitly model them for preservice teachers. To support teacher educators in developing technology skillsets, policy makers could allocate additional funds to provide professional development opportunities with leaders in the emerging technologies relevant to specific subject areas. I also recommend that policy makers work with teacher educators to reimagine the typical one-credit technology course requirement and consider new 'technology infusion' approaches in which preservice teachers experience learning and teaching with technology throughout all of their TEP settings (Foulger, 2020).

In addition to supporting TEPs in rethinking their technology use through a systems approach, I recommend urging policy makers to provide additional funds for TEPs to increase the level of media literacy education offered to preservice teachers. If national-level standards for teacher preparation (e.g., the Council for the Accreditation of Educator Preparation standards) require preservice teachers to learn how to integrate technology into their teaching practice, policy makers need to support this by providing time and funding to educate future teachers about how to be critical consumers and effective creators of media content. This support should take the form of professional development opportunities within and across subject areas, as well as being integrated into coursework so preservice teachers can develop their media literacy skills.

Limitations

My dissertation is limited primarily by the size of my participant sample and, but also by their overall level of technology use. I chose a sample size of six participants in order to manage

the interview and observation schedule within the time constraints dictated by my graduate student calendar. But my research is also limited by the fact that I focused preservice teachers who regularly used technology and there were no *low* technology users in my sample. While I tried to recruit cohort participants who self-reported low levels of technology through two rounds of email solicitations, I now recognize the inherent selection bias introduced by such an approach, and I realize that I should have attempted in-person contact with potential participants, in order to identify technology users of all levels. Although the low level users represented a low percentage of the cohort, my study could be improved by accounting for the experiences of people who use low levels of technology in their learning.

The second limitation of my dissertation concerns the forms of data collected: the majority of it was self-reported by participants. This means that the participants themselves chose what to disclose in our interviews, whether through verbal answers or choice of shared screenshots. As a result, relevant devices, applications, intentions, and contextual factors may be excluded. In response to this vulnerability, I conducted course observations and interviewed three university-based teacher educators and one instructional coach to gain insight from their perspective on their own use of technology in their teaching and on the expectations set up for their students (my participants). My study could have been stronger if I had interviewed more teacher educators and mentors who might have provided additional valuable perspectives through which I could have better understood the contextual factors described by the preservice teachers.

My data collection was also limited by the number of locations for collecting observational data. I observed the participants in their university and school classrooms, but not in their homes, other social settings (e.g., in the library or hanging out), or in transit (e.g., riding

the bus to class)—the H.O.T. settings outlined in Chapter 5. Originally, I decided not to observe them in these spaces because I felt restricted by my position as their instructor: because of our student-teacher relationship in class, I felt uncomfortable visiting with them in personal spaces such as their homes. Upon reflection, I could have asked them to record videos of themselves in these spaces to expand my observation data. I also did not observe the participants during lesson planning sessions with their mentors. I now believe that having first-hand observation notes on this process would have helped me triangulate my findings, thereby validating the complexity of each student teaching placement and mentor-mentee relationship.

Conclusion

I conclude this dissertation with an overall sense of optimism: this is a promising time to be studying preservice teacher learning and technology. The field of teacher education is increasingly adopting theories of learning that are based on research from the fields of learning sciences and technology and media studies, and these theories inform how preservice teachers are taught, and learn to teach with, technology (Kalir, 2016; Office of Ed Tech, 2017; Lohnes Watulak, 2018; Moran, 2018). Teachers educators are also beginning to embrace more emerging technologies and to envision future classrooms as offering equitable and authentic learning opportunities driven by students' interests, digital practices, real-world issues, and multiliteracies (Howard, 2014; Kjällander et al., 2018; Mirra, 2020). As a teacher educator and a researcher, I applaud and join with this movement in teacher education, and I endeavor, with the findings of this dissertation, to contribute evidence that reframes preservice teachers as unique technology users with personalized prior histories that help shape how they think about and use technology to support their learning and future teaching. With such a view, teacher educators can position

preservice teachers as knowledgeable technology users and work alongside these future teachers to support their learning needs and transform how technology is used in TEPs for years to come.

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Appendices

Appendix A. Qualtrics Survey Questions

Q1 Add your email address: _____

Q2 Select your age range
- o 18 - 22
- o 23-26
- o 27-32
- o 33-40
- o over 40

Q3 Your academic area of specialization
- o Art
- o Computer Science
- o Foreign Language
- o Health/Physical Education
- o History
- o Language Arts/English
- o Mathematics
- o Music
- o Science
- o Social Studies
- o Special Education
- o Drama
- o Vocational
- o Other _____

Personal Life Digital Practices

Q4 Please answer the following questions pertaining to how frequently you use technology and/or digital media hardware in your personal life:

	Never	Around 10 hours a week	Around 20 hours a week	Around 30 hours a week	More than 30 hours a week
Computer/laptop	o	o	o	o	o
Mobile phone	o	o	o	o	o
Tablet	o	o	o	o	o
E-reader	o	o	o	o	o
Television	o	o	o	o	o
Game console	o	o	o	o	o

Wearables	○	○	○	○	○
Voice assistant service enabled devices	○	○	○	○	○
Virtual/augmented reality	○	○	○	○	○
Other	○	○	○	○	○

Q5 Please answer the following questions pertaining to how frequently you use technology and/or digital media to engage in these activities:

	Never	Around 10 hours a week	Around 20 hours a week	Around 30 hours a week	More than 30 hours a week
Social Media	○	○	○	○	○
Emailing	○	○	○	○	○
Texting	○	○	○	○	○
Photographs	○	○	○	○	○
Blogging	○	○	○	○	○
Calendar/scheduling	○	○	○	○	○
News	○	○	○	○	○
Gaming	○	○	○	○	○
Navigation/Mapping	○	○	○	○	○
Reading	○	○	○	○	○
Videos	○	○	○	○	○
Music	○	○	○	○	○
Podcasts/radio	○	○	○	○	○
Cooking/recipes	○	○	○	○	○
Fitness	○	○	○	○	○
Other					

Q6 I use technology and/or digital media for Social Media to:

	Never	Around 10 hours a week	Around 20 hours a week	Around 30 hours a week	More than 30 hours a week
connect to a larger community of people	○	○	○	○	○
communicate with friends	○	○	○	○	○
communicate with family members	○	○	○	○	○
create new relationships (friends, dating, etc.)	○	○	○	○	○
maintain relationships (friends, dating, etc.)	○	○	○	○	○
create new online content	○	○	○	○	○
to share online content	○	○	○	○	○

Learning Experiences with Technology in High School

Q7 During your high school experience, technology and/or digital media was used by:

- All of my teachers
- Most of my teachers
- A few of my teachers
- None of my teachers

Q8 Describe a time when one of your high school teachers used technology and/or digital media effectively in their teaching.

_____
_____
_____
_____

Q9 While in your high school classes, you used technology and/or digital media in your learning:

- Once a month
- Once a week
- Once a day
- Multiple times a day

Q10 Describe a time when you used technology and/or digital media effectively in your learning in high school.

_____
_____
_____
_____
_____

Learning Experiences with Technology in Higher Education

Q11 Please rate the following items pertaining to how frequently you used technology and/or digital media devices IN or OUTSIDE THE CLASSROOM.

	Never	Around 10 hours a week	Around 20 hours a week	Around 30 hours a week	More than 30 hours a week
Computer/laptop	○	○	○	○	○
Mobile phone	○	○	○	○	○
Tablet	○	○	○	○	○
E-reader	○	○	○	○	○
Television	○	○	○	○	○
Wearables	○	○	○	○	○
Virtual/augmented reality	○	○	○	○	○
Other	○	○	○	○	○

Technology and/or Digital Media Use in Your Professional Field

Q12 How relevant is technology and/or digital media in your professional field (e.g., chemistry, history, art, physics, geography, health sciences)?

	Not relevant	Some what relevant	Unsure	Relevant	Highly Relevant
Technology and/or digital media is used	○	○	○	○	○

in the professional field in which I intend to teach	

Technology and/or Digital Media Use in Your Teaching

Q13 Please rate your own use of technology and/or digital media in your teaching practices:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I can find technology and/or digital media to enhance how I teach my lessons	○	○	○	○	○
I can use technology and/or digital media to enhance how I teach my lessons	○	○	○	○	○

Appendix B: Semi-structured Interview Questions

2018 Spring Quarter Interview	
Questions	**Probes**
It would be great to get to know you better and what brought you to the profession of teaching and your subject area. Can you tell me about your road to teaching? It would be helpful to know about your educational trajectory - both in formal (school) and informal (out of school) spaces. For example, where did you grow up? What was your childhood like? What have you been interested in as a student in and out of school?	What was your elementary, middle, high school years like? What did you like to do in school? Outside of school? Any special teachers in your life?
How did you become interested in your subject area?	What were your first experiences with your subject area? What positive or negative experiences have you had with it? What role models have you had in the area? What are you passionate about in the subject area?
I know this question is a little cliche - but tell me about why you want to be a teacher.	When did you know you wanted to be a teacher? What type of teaching placement are you hoping for after graduation?
Teacher Education Program Questions	**Probes**
Let's talk about your education as a teacher. How is your first quarter going in your TEP? What technology have you been using?	How are your classes? Is the program what you were expecting? Tell me about your specific classes and what technology you use.

Now - let's talk about you use digital technologies for TEP. Let's start with your fantastic screenshots. Tell me about the process - how did you think about taking these? When/where did you take them? Did this documentation process make you think any different about your tech use?	Depending on the artifacts – ask about specific devices, when, where, why they were used.
Artifact-elicited portion: Can you tell me more about what you have captured in these pictures?	What devices How do you use them When Where Why Are you using digital technologies to interact with peers? Learn new information? Connect to other communities?
Have you used digital technology to bring new/different information into your lessons? DT to bring new teaching or learning practices into your program?	Ask for specific about the contextual factors, devices, media.
Now that we can see some of your technology use in TEP all together - can you see any changes in your uses of it? For example - do you use something more - or less?	Are you using new devices? New digital programs? New digital practices before or during TEP?
Now that we can see some of your technology use in TEP all together - can you see any changes in your uses of it?	Are you using new devices? New digital programs?

For example - do you use something more - or less?	New digital practices before or during TEP?
How is technology positioned in your classes? For example, are you encouraged to use it? In class? For assignments? Did you use DT in your middle school placement?	Methods courses? Development?
Wrap-up Questions	
How do you think about digital technologies and your teaching?	
How do you think about your students' lives with digital technologies?	
Is there anything that I forgot to ask you or that you would like to include in this interview?	

2018 Summer Quarter Interview	
Your Technology Class Assignment Questions	**Probes**
I am interested in the piece you made for our tech class about your life with technology. Can you reflect back on the process and talk to me about what you learned and what you made? Let's start with your notes on your digital practices. What did you notice? Then how did you decide to make this representation? Please describe it for me. Now that you have made this piece, is there anything about your digital life that you forgot to add?	Ask more questions about specifics for using each device/program. What do you do on FB/other SM platforms? As you think about your life in TEP and outside of TEP - do these worlds feel separate? Do you use DT outside of the program in ways that you don't use in TEP?

*Try to get a picture of their digital life and what agency they exercise using the different programs. Do you use DT outside of the program in ways that you don't use in TEP? What does your family say about your digital practices? How do you think about your digital practices? How do you think about technology in your life?	Do you use your phone a lot outside of TEP? What do you do on there?
Technology Use in TEP Questions	**Probes**
Let's talk about your summer quarter in your TEP. How did you use technology in your TEP? Can you walk me through how you use technology in each of your classes? And how the professors/instructors/TAs/mentor teachers position / support your technology use?	Each class: 1. MCE 2. Topics and Tensions 3. ELL Workshops 4. Tech 5. Tribal Sovereignty 6. L&L
Now - let's talk about you use digital technologies for your TEP. Let's start with your fantastic screenshots. Tell me about the process - how did you think about taking these? When/where did you take them? Did this documentation process make you think any different about your tech use?	Specifically - at the summer school A. how was technology talked about? B. how was it used? C. Did you use it in your lesson preparation? In your teaching?

	D. How do you think technology plays a role in your students' lives? E. Did this experience change you think about technology and teaching and learning?
Changes or consistencies in your practices?	Ask for further details
Is there anything else you want to add in relationship to your learning / technology/ teaching in your TEP this summer or last spring?	
Wrap up Questions	
Is there anything that I forgot to ask you or that you would like to include in this interview?	
Moving forward - are you on break? Please keep notice of how you are using technology in your life - in / middle / out of your TEP :) Same routine….reminder email, observation, interview But now you will be in your placement! Let's see if /how you use technology in this new space and how it shapes your practices and thinking	

2018 Fall Interview Questions	
Introduction Questions	**Probes**
Intro - How is your quarter going?	How are your classes going? How is your student teaching placement going? What school? What is your mentor teacher like?

A big part of my study is exploring the complexity of teacher candidates' life with technology. I want to make sure that I understand all of the cool things you are doing with technology - both in and out of school. I went back and listened to our first two interviews and observations and I made this list of your technology devices & practices. I would love if you could read this and add anything I am missing on the spring and summer tables - and then - can you fill in what you have been doing in the fall.	For example - is anything the same? Different? Are you using the same programs for different reasons?
Now that you have looked at this visual list of your devices and applications that I have been collecting over our year together. What can we add for this quarter? Can you talk to me about how you think about technology in your life?	What does technology do for you? Do you connect to people? Find information? Make content? Relax? Play games?
Technology Use in Your TEP & Field Placement	**Probes**
How have you been using technology in your classes?	TEP classes? School placement?
How have you been using technology in your student teaching placement?	How are you using technology as a student teacher? How does your mentor teacher use and talk about technology? How do your views of DT in teaching and learning align with how your mentor teacher uses it?

How have you used technology in your school?	What have you done? Or what do you want to do? What are some lessons you have learned about student use of TDM now that you've had time to experience it firsthand? What do you still wish you were able to do with students and TDM in the classroom?
Let's talk about using technology in your subject area. How are you thinking about technology and your subject area? What does technology enable or constrain you from doing?	Devices Software Goals/intentions Student interest
Let's talk about how technology and your middle/high school students.	How do you think about your students' lives and technology? How are they using technology in your school?
Your Artifacts	**Probes**
Now - let's talk about you use digital technologies for your TEP. Let's start with your fantastic screenshots. Tell me about the process - how did you think about taking these? When/where did you take them? Did this documentation process make you think any different about your tech use?	Specifically - at the your placement A. how was technology talked about? B. how was it used? C. Did you use it in your lesson preparation? In your teaching? D. How do you think technology plays a role in your students' lives?

Wrap Up
Is there anything that I forgot to ask you or that you would like to include in this interview?

2019 Winter Interview Questions	
Interview Questions	**Probes**
Intro - Tell me about your ST quarter! How is it going? How was your 6 weeks of fulltime ST? What is your relationship like with your students? What is your relationship like with your mentor teacher? I am interested to hear about what it was like to work with your mentor teacher. Now that you have had this teaching experience, has your ideas about technology and your content area changed? Technology and your teaching? Technology and your students learning? Anything else about your placement you would like to talk about?	Did they let you try your ideas? Curriculum? Instructional strategies? Technology? Did they use technology? Did they let you try new technology?
Personal Technology Use	
I have data about how you use technology as a student – in TEP coursework - but now that you have completed your ST experience - I would love to know about your life as a teacher. Let's start by looking at the screenshots - tell me about what you have here.	Ask about personal life - changes? Consistencies? Using existing practices for new reasons? Ask to look at TEP again - anything to add?

Can you describe what you see here – and what was your goal for using the device/media? Ask about personal life - changes? Consistencies? Using existing practices for new reasons? Ask to look at TEP again - anything to add?	
Theme Questions	**Probes**
How you use tech to support your learning - making your own moves with DT Discuss questions based on these themes: -Taking evidence - phone and laptop to use later (or collecting for future) -Participation - relationship with the MT, other educators, interactions with students -Tech to learn new info or skills -Use tech to solve problems? How/where did you know how to do this? -Creating digital content? -adding to others content? -digital tools to create own content? **Relationships:** -TC peer -Friends, family, interest-based communities **Media Consumption: news, music, popular culture, etc.** -Connecting in and outside of class practices -influencing thinking/teaching **Future - as a teacher -** collecting resources? Connecting to communities?	For each question – ask for specifics in terms of devices/media/goals/and other contextual factors based on their answers.

Add any specific examples from PSTs last interview Taking pictures on phone -student work Content creation - PPs -now -will you use it for the future Identity - do you consider yourself a tech person? Content area & tech follow ups TEP Facebook group participation	
Wrap up	
Is there anything that I forgot to ask you or that you would like to include in this interview? I want to thank you for participating in my study. I really enjoyed working with you this year and I hope we can stay in touch.	

Appendix C: The Complete List of My Categories and Codes

Category	Digital Technology Use in TEP Classes
Definition	Examples of digital technology (DT) used during the spring, summer, and fall quarters. Attention to devices and applications. Most evidence is based in TEP campus classes. Preservice teacher (PST)
Subcategory	Teacher Educator (TE) Directed Practices
Code: Changes in DT practices suggested by TE	
Code: TE directed collaboration with peers using Google Docs/Slides	
Code: Lack of TE DT use (focusing on other material tools)	
Subcategory	PSTs using DT to support their learning in their TEP
Code: Immediate problems	
Code: Support pedagogy problems	
Code: Collaborating with peers using Google Docs/Slides	
Code: PSTs choose to use Google Doc/Slides for assignments	
Code: PSTs setting up shared DT space to collect information for future use	
Code: PSTs using DT to give peer access to information	
Code: PSTs using tech to support each other in their TEP	
Subcategory	Subject area technology use
Code: Tech connected to subject area industry	

Code: Use tech to learn about subject area content	
Code: Tech use connected to methods class	
Subcategory	DT Use within and across classes
Code: PSTs thinking about tech and teaching	
Code: Issues with tech	
Code: Canvas use	
Code: Application use	
Code: Tech that spans classes	
Code: Tech when working with coaches	
Code: Practices changing	
Code: Evidence of teaching	
Code: New uses of existing tech	
Code: Multiple tech used together	
Code: Changes in PST attention/energy from quarter to quarter	
Code: Pictures for discussion	
Code: No tech use for F2F participation	
Subcategory	Personal preferences for learning
Code: Access information everywhere	

Code: Visual learning
Code: Need social support
Code: Organize schedule
Code: Time tracking
Code: Organize information
Code: DT as Distractions
Code: Using past practices while in their TEP
Code: PSTs talk about how they learn - and connect to tech uses
Codes: PSTs act intentionally with DT for their learning
Code: family influences
Code: friend influences
Code: high school uses
Code: university uses
Code: work experiences

Subcategory	Connecting in and out of school DT use
Code: In-school tech uses impacting out-of-school tech uses	

Code: Taking up new DT practices	
Code: Influence of social media on teaching practice	
Code: Influence of music on teaching practice	
Code: Influence of news on teaching practice	
Category	PSTs take and collect photographs/screenshots in their TEP
Code: Record personal work to use outside of class	
Code: Record group work to use outside of class	
Code: Record work with mentor teacher to use outside of classroom	
Code: Personal access to information	
Code: Record assignments	
Code: Remind self of experiences to use in assignments	
Code: Fast capture of information	
Code: Support student learning	
Code: Record classwork to use in class	
Code: Take visual records of school placement, museums, resources, maps, schedule	
Code: Take pictures/ss of personal interests	

Code: Take pictures of resources to use in teaching immediately

Category	**PSTs use DT to Add Content to Lessons/Teaching**
Definition	PSTs use different devices and applications to search for, select, alter or create digital media to improve lessons or teaching.
Subcategory	Use pre-made content without changing it
Code: Searching and selecting music	
Code: Searching and selecting videos	
Code: Searching and selecting social media	
Subcategory	Remix/adapt/alter pre-made content and add their own voice
Code: Remix content from web	
Code: Remix teacher made content	
Code: Remix PPs	
Subcategory	PSTs using digital tools to create entire content
Code: PST make paper-based content	
Code: PST making PPs	
Code: Making digital media	

Category	**PSTs using DT to develop relationships**
Definition	PSTs use DT in different ways in their personal and TEP-based relationships

Subcategory	PSTs intentions and actions for using DT regarding relationship building and maintaining
Code: TEP-based relationships around TEP content	
Code: TEP-based friendship-based relationships	
Code: Intentional choice to not engage in friendship building	
Code: Developing relationships with sharing digital content	
Code: Facebook Group	

Category	**PSTs using DT for future uses**
Definition	PSTs using their preferred programs to collect and create resources for their careers as teachers.
Subcategory	Using DT to create personalized collections of resources
Code: Collecting resources for the future	
Code: Creating content for the future	
Code: Future tech uses	

Category	**Personal - what the TC brings to their TEP**
Definition	Information about PSTs' prior histories with DT
Subcategory	Examples of DT use before TEP
Code: PSTs family and tech	
Code: PSTs tech use - K-12	

Code: PSTs agency in life
Code: Why become a teacher?
Subcategory PST's unique digital practices
Code: AM practices
Code: PM practices
Code: School learning
Code: Stacking tech & programs
Code: Change in practices
Code: Consistency in practices
Code: Identity with tech
Code: Judgment about using tech
Code: Location of DT use
Code: DT to further personal interests
Code: DT for personal relationships

Category	**Mentor Teacher Classroom DT Examples**
Definition	An exploration of the MT's planning, teaching, and assessment practices with technology (or without it)
Subcategory	MT's uses and discussions of DT
Code: MT phone policy	

Code: Information about MT's pedagogical approaches
Code: MT actions with technology
Code: MT DT uses for planning
Code: MT DT uses for instruction
Code: MT discussions about DT
Code: MT DR uses for assessment
Subcategory TC's actions in relation to MT's DT practices
Code: Agency with DT in MT's classroom
Code: Agency w/out DT in MT's classroom
Code: TC discussions with MT about technology
Code: TC working with peers in field placement school